SEARS

owners manual

MODEL NO.

161.21056

Caution:
Read Rules For Safe Operation and Complete Operating Test Procedures Carefully

SEARS / CRAFTSMAN®
DIAGNOSTIC OSCILLOSCOPE

- OPERATING INSTRUCTIONS
- REPAIR PARTS

SEARS, ROEBUCK AND CO. U.S.A.
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RULES FOR SAFE AUTOMOTIVE TESTING

WARNING — READ CAREFULLY

Read this Operation Instruction Manual and these Rules for Safe Automotive Testing carefully. Failure to follow instructions and safety rules could result in serious bodily injury and/or damage to the instrument.

1. Before starting the engine, set the parking brake and place the gear selector in NEUTRAL on standard transmissions, and PARK on automatic transmissions.
2. The carbon monoxide in exhaust gas is highly toxic. To avoid asphyxiation, always operate vehicle in a well-ventilated area. If vehicle is in an enclosed area, exhaust should be routed directly to the outside via leak-proof exhaust hose.
3. To avoid explosion due to spark when operating any test instrument from an auxiliary battery, connect a jumper wire between the negative terminal of the auxiliary battery and chassis ground on the vehicle under test for negative ground systems. For positive ground systems, connect the jumper wire to the positive terminal of the auxiliary battery and chassis ground on the vehicle. When working in a garage or other enclosed area, auxiliary battery should be located at least 18 inches above the floor to minimize the possibility of sparks igniting gasoline vapors and causing an explosion.
4. An automobile battery is capable of producing very high currents. Therefore, exercise reasonable care when working near the battery to avoid electrical connections through tools, wristwatch, etc.
5. Avoid contact with battery electrolyte. Electrolyte can burn holes in clothing, burn skin and cause permanent damage to eyes. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In case of eye contact, seek medical aid immediately.
6. The gases generated by a charging battery are highly explosive. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is charging. Any room or compartment containing charging batteries should be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while battery is charging, and always turn charger off before disconnecting the battery clips. When removing or reconnecting battery cables, make sure ignition switch and all accessories are turned off. A technique used by many mechanics is to carefully blow across the top of the battery to remove any hydrogen gas accumulation before connecting or disconnecting battery clips.
7. Never add acid to a battery once the battery has been placed in service, doing so may result in dangerous spattering of electrolyte.
8. Keep hands, hair, necktie, loose clothing and test leads well away from fan blades, fan belt, power steering belt, air conditioner belt and other moving engine parts as serious injury could result from entanglement.
9. Do not touch hot exhaust manifold, radiator or high-voltage spark plug and coil terminals. Spark voltages are not normally lethal but an involuntary jerk of the hands or arms caused by electrical shock may result in injury.
10. Never look directly into carburetor throat while engine is cranking or running. A sudden backfire can cause serious burns.
11. To avoid the possibility of a flash fire, do not smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump or other potential sources of spilled gasoline or gasoline vapors.
12. Never remove radiator cap while the engine is hot. Hot coolant escaping under pressure can cause serious burns.
13. The jack supplied with the vehicle should be used only for changing wheels. Never crawl under car or run engine while vehicle is on jack.
14. When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or an explosion.
15. Do not let test cables rest or fall on or near hot or moving engine parts.
16. Use caution when disconnecting ignition cables. Pull cables carefully at the boot with the proper tool.
17. Always turn the scope OFF before disconnecting it from the battery.

FULL ONE-YEAR WARRANTY

If, within 1 year from the date of purchase, this automotive test instrument fails due to a defect in material or workmanship, RETURN IT TO NEAREST SEARS STORE IN THE UNITED STATES, and Sears will repair or replace it, free of charge.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

SEARS, ROEBUCK AND CO. • DEPARTMENT 698/731A
SEARS TOWER • CHICAGO, IL 60684

CHAPTER 1.
INTRODUCTION

1.1 INTRODUCTION This owner's manual describes the Sears' Craftsman Model 161.21056 Diagnostic Oscilloscope and the tests that it can do. Prior to performing any oscilloscope test, however, it is important that the technician understands how to use this manual and how to apply the tests described for the specific vehicle being serviced.

IMPORTANT

CONSULT THE VEHICLE SERVICE MANUAL FOR SPECIFIC TUNE-UP INFORMATION AND TEST PROCEDURES. ALWAYS FOLLOW THE MANUFACTURER'S SPECIFICATIONS AND TEST PROCEDURES FOR ADJUSTING DWELL ANGLE, IDLE SPEED AND CHARGING SYSTEM OUTPUT, ESPECIALLY VEHICLES WITH MODERN ELECTRONIC IGNITION AND EMISSION CONTROLS. DO NOT ATTEMPT TO SERVICE A VEHICLE WITHOUT THE MANUFACTURER'S INSTRUCTIONS AND SPECIFICATIONS.

1-2. VEHICLE MANUAL. SOURCES FOR SERVICE INFORMATION. The following is a list of publishers who have service manuals for your specific vehicle at nominal cost. Write to them for availability and prices, specifying the make, style, and model year of your vehicle.

American Motors Corporation
Myriad
8835 General Drive
Plymouth Township,
Michigan 48170

Chrysler Corporation
Dyment Distribution Service
Service Publication
20026 Progress Drive
Strongsville, Ohio 44136

Ford Publication Department
Helm Incorporated
Post Office Box 07150
Detroit, Michigan 48207

Buick
Tuar Company
Post Office Box 354
Flint, Michigan 48501

Oldsmobile
Lansing Lithographers
Post Office Box 23188
Lansing, Michigan 48909

Cadillac, Chevrolet, Pontiac
Helm Incorporated
Post Office Box 07130
Detroit, Michigan 48207

OTHER SOURCES
NONFACTORY

Domestic and Import Cars

Chilton Book Company
Chilton Way
Radnor, PA 19089

Cordura Publications
Mitchell Manuals, Inc.
Post Office Box 26260
San Diego, CA 92126

Motor's Auto Repair Manual
Hearst Company
250 W. 55th Street
New York, N.Y. 10019

1-3. OSCILLOSCOPE MANUAL. Although the tests in this manual are presented in the most efficient order [illegible] testing it is not critical to follow this order. Each test contains a complete set of hook-[illegible] instructions which are unique to the particular ignition system being tested. This allows the technician to perform any test independently from all other tests or other vehicle specifications. When performing [illegible] tests it is important to read each test through, as differences between test instructions are often [illegible]. The information in this manual will serve as a general guide for engine tune-up and [illegible] and adjustments.

1-4. TEST SELECTION FOR VEHICLE. To determine which tests apply to the specific test vehicle, consult the vehicle service manual and CHAPTER 5 in this manual.

1-5. SAFETY INFORMATION. Throughout this manual information which is especially critical to personnel [illegible] is presented as notes which interrupt the text. The terms "WARNING", "CAUTION", and [illegible] have the following meanings.

WARNING

Warning notices are used to emphasize conditions in the operation of the equipment that could cause harm to personnel.

CAUTION

Caution notices are used to emphasize conditions in the operation of the equipment that could cause damage to equipment.

NOTE

Notes call attention to information that is especially significant in understanding, or operating, this equipment.

1-6. GENERAL INFORMATION.

A. **Oscilloscope Testing.** The Model 161.21056 Diagnostic Oscilloscope provides a visual means of observing the performance of an automobile ignition system. Using the oscilloscope (scope) and this manua the technician follows hook-up and test procedures to test for specific ignition problems. He compares the test patterns displayed on the scope with the patterns illustrated in this manual, patterns generated by ar ignition system that is functioning properly. Differences and variations in patterns indicate defective components which cause the system to operate improperly. By performing the tests and comparing scope patterns, defective components can be located and repaired or replaced.

B. **Oscilloscope Patterns.** The unique test procedures and methods included in this manual place attention on individual portions of a scope pattern in a logical sequence. This sequence assures the technician that every portion of the waveform will be analyzed accurately and makes locating problems almost automatic. This diagnostic sequence allows complete engine ignition system testing to be performed even without a full understanding of the scope pattern.

C. **Oscilloscope Features.** The Diagnostic Oscilloscope has several features that make scope testing clear and simple. The spark voltage pattern yields a sharp, uncluttered picture of the spark voltage peaks, allowing the technician to analyze problems easily. The clamp-on INDUCTIVE PICK-UP and CAPACITIVE PICK-UP provide more stable patterns and eliminate the need to disconnect ignition wires during hook-up. A large 9-inch screen, rotary function selector, automatic focusing, and brightly illuminated pattern display are among the other highlights of this scope. It should be noted that this scope does not require a separate battery adapter and shunt resistor for alternator testing. The alternator signal is sensed at the alternator output terminal or at the positive battery post. The most outstanding features of this scope are the simplicity of the front panel controls, and the ease of testing provided by the test procedures.

CHAPTER 2.
OSCILLOSCOPE CONTROLS, CONNECTIONS, AND ACCESSORIES

2-1 DESCRIPTION. The Model 21056 Oscilloscope has clearly labeled controls on the right as shown in Figure 2-1. The screen provides a clear, sharp contrast display of patterns with a vertical dwell scale on the left and horizontal dwell scale for 4, 6, and 8 cylinder vehicles across the bottom. The connector sockets on the scope are color coded and keyed to their corresponding connector plugs. Controls, connections and accessories are illustrated in Figure 2-1 and described in Table 2-1.

Table 2-1. **Oscilloscope Controls, Connections, and Accessories**

1. POWER ON SWITCH

Momentarily pressed to turn the oscilloscope ON after the power lead has been connected to 12 volts. The POWER ON SWITCH illuminates to indicate power on.

2. POWER OFF SWITCH

Momentarily pressed to turn the oscilloscope OFF before disconnecting power lead from 12 volts. If a power supply lead is accidentally disconnected, the scope must be turned ON again after the lead has been reconnected.

3. FUNCTION SELECTOR

Used to select the proper ignition or alternator pattern required for each test.

4. VERTICAL POSITION CONTROL

Used to adjust the vertical position of the pattern on the scope screen.

5. PATTERN POSITION CONTROL

Used to adjust the horizontal position of the pattern on the scope screen.

6. PATTERN LENGTH CONTROL

Used to adjust the horizontal length of the pattern on the scope screen.

7. POWER LEAD

Connects the scope to the 12-volt battery of the vehicle being tested or an auxiliary 12-volt battery.

8. INDUCTIVE PICK-UP

When clamped over the wire of the first spark plug in the vehicle's firing order, the Scope displays patterns in firing order for the cylinders without regard to the engine speed or number of cylinders.

9. CAPACITIVE PICK-UP

When clamped over the high tension ignition coil wire, the Scope displays the secondary high voltage pattern.

10. HEI PATTERN CAPACITIVE PICK-UP

Connects to the top of the General Motors HEI integral coil distributor systems, and is used in place of the CAPACITIVE PICK-UP. Item 9 above.

11. ALTERNATOR LEAD WITH BLUE CLIP

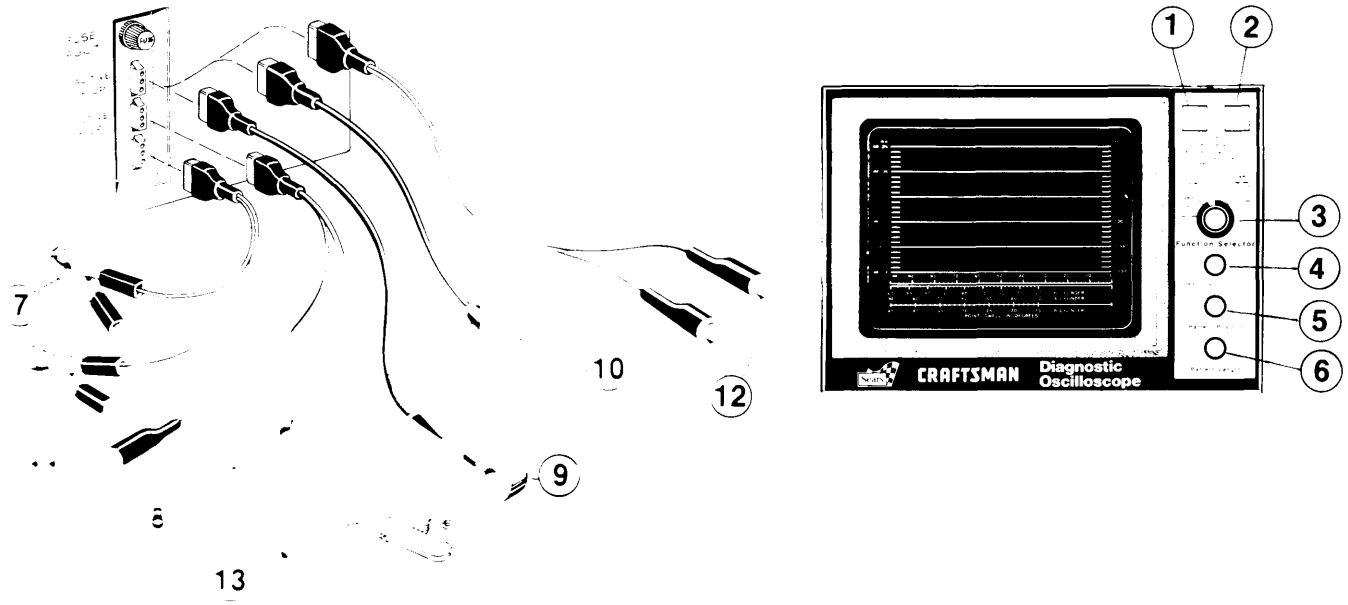
Connects to the Positive (+) terminal of the alternator or + battery terminal when alternator is inaccessible. Scope displays the voltage pattern.

12. PICK-UP COIL TEST LEAD

Connects to the CAPACITIVE PICK-UP socket on the back of the scope and to the magnetic pick-up coil of electronic ignition systems. Tests the magnetic trigger unit in the distributor on electronic ignition systems.

13. FIBER PLIERS

Used to remove the spark plug wires.



Oscilloscope Controls, Connections,and Accessories

FIGURE 2-1.

CHAPTER 3.
TEST DESCRIPTIONS

3-0. GENERAL. The Sears Craftsman Diagnostic Oscilloscope may be used to perform many engine tests. The twelve most common tests are outlined below and described in detail in the following chapters.

> **CAUTION**
> The scope obtains its power to operate from the 12 volt car battery. If you are servicing a vehicle with a 6 volt battery system, you must use a 12 volt auxiliary battery for the scope. Connect a jumper wire between the negative (-) terminal of the auxiliary battery and ground on the vehicle being tested. Connect the red power lead clip from the scope to the positive (+) terminal of the auxiliary battery and the black clip to the negative (-) ground of the vehicle under test.

3-1. SPARK POLARITY TEST. Incorrect polarity in the primary or secondary circuit can result in a 20-40% greater voltage requirement to fire the spark plugs and may cause the engine to misfire under load or at high speed. This test checks for correct polarity in the entire ignition circuit. Refer to Chapter 6.

3-2. MAXIMUM COIL OUTPUT (AVAILABLE VOLTAGE) TEST. For any ignition system to function properly, the ignition coil must be able to produce high secondary voltage. Failure of the ignition coil to produce adequate voltage may cause the engine to misfire under load or at high speed. The maximum secondary voltage produced by an ignition coil can be measured in this test to ensure adequate voltage. Refer to Chapter 7.

3-3. SECONDARY INSULATION TEST. The secondary ignition circuit is the path for voltage from the coil to the gap of the spark plugs' electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug. Refer to Chapter 8.

3-4. SPARK VOLTAGE UNDER LOAD TEST. The spark voltage of all cylinders should be fairly uniform and rise slightly when the engine is "snap-accelerated." This test measures and compares the voltage requirements of each cylinder in an engine under load to determine if any faults are present. Refer to Chapter 9.

3-5. DWELL AND VARIATION IN DWELL TEST. Dwell is the period that the distributor points are closed during each cylinder ignition firing cycle. This test measures the variation of dwell among all the cylinders to determine specific faults in the distributor. Refer to Chapter 10.

3-6. COIL/CONDENSER TEST. Energy remaining in the coil after the spark plug has fired must be dissipated properly to protect the points. This test measures the dissipation of the voltage and determines if there is a fault in the coil or the condenser. Refer to Chapter 11.

3-7. POINT ACTION TEST. It is important that the points open and close properly for each spark plug firing. This test checks for proper action of the breaker points. Refer to Chapter 12.

3-8. SECONDARY RESISTANCE TEST. A limited amount of resistance is built into the secondary circuit to extend the spark plug electrode life and to minimize interference with radio and television reception. Excessive resistance dissipates the energy otherwise needed to maintain good ignition during high speed operation. This test checks for excessive secondary resistance. Refer to Chapter 13.

3-9. COIL OUTPUT AT CRANKING SPEED TEST. A fault in the primary circuit or a defective coil may cause an engine to be hard to start or fail to start. This test determines if these systems are the cause of a starting problem. Refer to Chapter 14.

3-10. ROTOR GAP TEST. Adequate voltage is required to properly arc the gap between the rotor and the distributor cap terminals. This test measures the voltage of the arc to determine possible faults in this circuit. Refer to Chapter 15.

3-11. ALTERNATOR TEST. Faults in alternator operation may be determined by analysis of the scope patterns produced in this test. Refer to Chapter 16.

3-12. MAGNETIC PICK-UP COIL TEST. Some electronic ignition systems use a magnetic pickup in place of contact points. Faults in operation of the magnetic pickup may be determined by this test. Refer to Chapter 17.

CHAPTER 4.
BASIC SCOPE PATTERNS

4-1. INTRODUCTION.

A. The ignition system is one of the most important systems of a gasoline engine. It delivers the spark to fire the right cylinder at precisely the right time while compensating for the engine speed and load. Proper functioning of this system and each of its many components is critical to the efficient operation of the engine.

B. The oscilloscope is a precision instrument used to diagnose problems in the ignition system while the engine is running. By representing the voltage circuits of the ignition system as waveform patterns on a monitor, a technician can diagnose the condition of each component in the system. This manual graphically depicts normal and unsatisfactory patterns for each test facilitating easy diagnosis of the ignition system. To utilize the oscilloscope fully, the technician should familiarize himself with the various function displays of the oscilloscope, the basic pattern of each display, the basic sections of specific patterns, and the terms used in this manual.

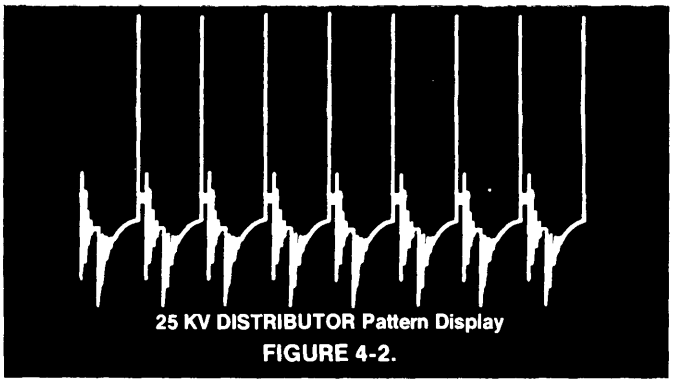
4-2. FUNCTION DISPLAYS.

The Diagnostic Oscilloscope Model No. 161.21056 provides five functions. Each function creates a different display on the oscilloscope screen. These functions and displays are selected with the FUNCTION SELECTOR (3, Figure 2-1) where they are labeled 50 KV COIL, 25 KV SPARK, DISTRIBUTOR PATTERN, 25 KV SUPERIMPOSED, and ALT.(alternator). The displays are adjusted with the VERTICAL POSITION CONTROL (4), the PATTERN POSITION CONTROL (5), and the PATTERN LENGTH CONTROL (6), as described in each test, to select and locate a waveform pattern on the oscilloscope screen for test measurement, observation and interpretation.

A. **50 KV Coil.** This function displays the complete series of spark ignition voltages for all the cylinders of the test vehicle, as illustrated in Figure 4-1. When properly adjusted, the waveform pattern provides the technician with an overall view of all the spark ignitions in their proper firing order. By comparison and measurement, the technician can determine and locate an abnormal ignition condition in one or all of the cylinders. This is a calibrated scale for measuring maximum available high voltage delivered by the ignition coil when one spark plug wire is disconnected.

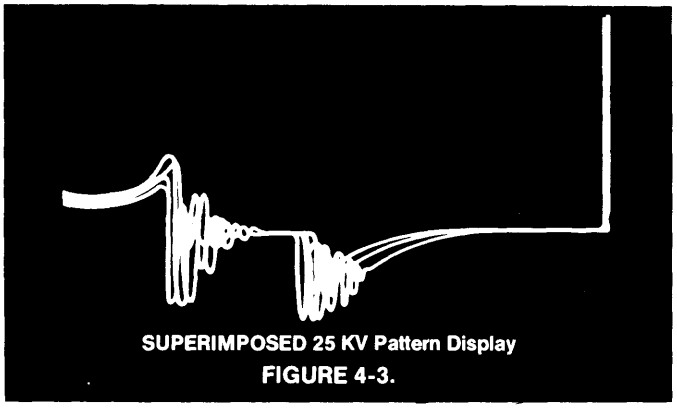
50 KV COIL Pattern Display
FIGURE 4-1.

B. **25 KV Spark.** This is a calibrated voltage scale and displays the voltage required to fire each of the spark plugs in the test vehicle as illustrated in Figure 4-4. When properly adjusted this pattern provides the technician with an overall view of all the spark voltages in their proper firing order. This pattern appears as four, six, or eight vertical lines according to the number of cylinders in the test engine. The height of these lines represents the peak amplitude of the voltage. By comparison and measurement, the technician can determine and locate an abnormal spark plug firing condition for one or all of the cylinders (too high or too low).



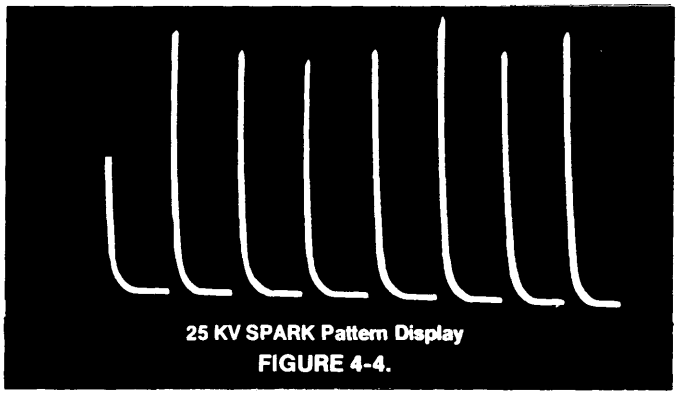
25 KV DISTRIBUTOR Pattern Display
FIGURE 4-2.

C. **Distributor Pattern.** Refer to Figure 4-2. This function display is the same as the 50 KV COIL display but is twice the height on the screen. When properly adjusted, this pattern provides the technician with an easy-to-read pattern of any specific cylinder. Through measurement and observation, the technician can determine and locate an abnormal ignition condition within the firing of a specific cylinder. This is not a calibrated voltage scale, but is provided to illustrate the waveshapes in the Spark Line and oscillation which must be present for a normal system.

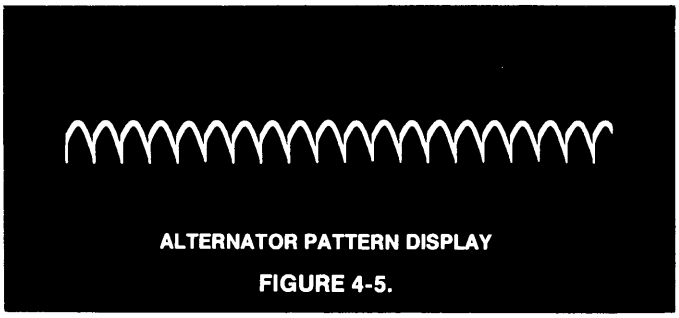


SUPERIMPOSED 25 KV Pattern Display
FIGURE 4-3.

D. **25 KV Superimposed.** This function displays the patterns of the spark ignition voltages of all the cylinders at the same time. The patterns for all the cylinders appear superimposed upon each other, as illustrated in Figure 4-3. When properly adjusted, this display provides the technician with as easy to read comparison of all the cylinders, and in particular, dwell variations between cylinders.



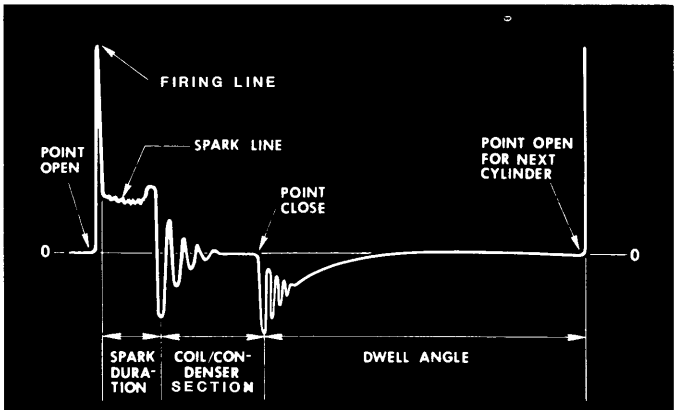
25 KV SPARK Pattern Display
FIGURE 4-4.



ALTERNATOR PATTERN DISPLAY

FIGURE 4-5.

E. **Alternator.** Refer to Figure 4-5. This function displays the ripple content of the test vehicle alternator. When properly adjusted, this display provides the technician with a waveform pattern for comparison and measurement to determine and locate an abnormal alternator output condition. Open and shorted diodes and windings (rotors and stators) can be found easily by waveform comparisons.



SPARK PLUG IGNITION PATTERN

FIGURE 4-6.

4-3. SPARK PLUG IGNITION PATTERN. (Breaker Point Ignition) The Spark Plug Ignition Pattern represents the voltage of the spark plug and distributor through a single spark plug firing sequence. The various phases of this voltage sequence can be identified easily as three distinct sections of the waveform pattern. These sections are the firing section, the coil/condenser section, and the dwell section. Figure 4-6 illustrates the normal scope pattern for the firing of one cylinder in a typical Breaker Point Ignition System.

A. **Firing Section.** The firing section of the Spark Plug Ignition Pattern is composed of the firing line and the spark line.

1. **Firing Line.** The firing line represents the initial voltage required to arc the rotor and spark plug gaps. This section displays a sharp vertical line extending upward. The components which affect this section are the spark plug, the plug wire, the rotor, the rotor gap, the distributor cap, the coil wire, the fuel mixture, and the cylinder compression. Abnormal conditions with any of these components will affect the height of the firing line displayed on the scope.
2. **Spark Line.** The spark line represents the voltage which is required to maintain a spark at the spark plug gap to burn the fuel mixture in the cylinder. This section of the pattern displays a nearly horizontal line extending to the right of the vertical firing line but should show some random ripple due to the burning air/fuel mixture. The components which affect this section are the spark plug, the plug wire, and the coil wire, as well as air/fuel mixture, cylinder condition and compression. Abnormal conditions with any of these components will affect the angle and continuity of the spark line.

B. **Coil/Condenser Section.** The coil/condenser section of the Spark Plug Ignition Pattern represents the dissipation of energy remaining in the coil and condenser after the spark plug has finished firing. In the waveform, this section displays a line of several oscillations which extend to the right from the spark line and diminish in size. The components which affect this section are the coil, the condenser, coil wire or in the case of electronic ignition possibly the module. Abnormal conditions with any of these components will affect the appearance of the oscillations in this section of the pattern.

C. **Dwell Section.** The dwell section of the Spark Plug Ignition Pattern is composed of the point-close signal and the point-open signal.

1. **Point-Close Signal.** The point-close signal represents the closing of the points and the build-up of the magnetic field in the coil primary by the flow of current through the coil. This signal displays a series of several diminishing oscillations. The components which affect this signal are the ignition points, condenser, and the coil. Abnormal conditions with any of these components will affect the appearance of the oscillations in this section of the pattern.
2. **Point-Open Signal.** The point-open signal represents the opening of the points and the end of the dwell section. This signal appears as an abrupt 90 degree upward angle of the pattern line. The components which affect this signal are the coil, condenser, and the ignition points. Abnormal conditions with these components will affect the abruptness of the upward angle.
3. **Dwell Section Length.** The length of the dwell section from the point-close signal through the point-open signal is affected by the dwell setting.

CHAPTER 5.
TYPES OF IGNITION SYSTEMS

5-1. INTRODUCTION. To perform any oscilloscope test, the technician must have the ability to select the correct tests for the specific vehicle being tested. Prior to the early 1970's, breaker point ignition systems were the automobile industry's standard. For these systems, the oscilloscope hook-up procedures, test procedures, test results, and oscilloscope waveform patterns are identical with a few minor exceptions. In 1973, Chrysler Corporation introduced the Electronic Ignition System as standard equipment on its entire passenger car line. This system replaced the breaker points with a magnetic pickup and transistor switching circuit. Each major automobile manufacturer has since designed, developed, or adapted a variety of electronic improvements of the breaker points ignition system. The result of these improvements has affected oscilloscope testing in a variety of ways. Each system has a distinctively unique oscilloscope waveform pattern, and falls into a variety of groupings for hook-up procedures, test procedures, and test results. For this reason, it is essential that the technician know which ignition system is used in the test vehicle in order to select the appropriate oscilloscope tests as described in this manual.

A. **Identify Ignition System.** Refer to Table 5-1 to identify the test vehicle's ignition system. Refer to the vehicle manufacturer's service manual to verify this identification.

B. **Select Tests.** Refer to Table 5-2 to select the appropriate oscilloscope tests.

Table 5-1. Ignition System Identification

Manufacturer/ Year	Ignition System	Qualification
AMERICAN MOTORS		
Thru 1974	Breaker Point Ignition (BPI)	All
1975-1977	Prestolite Breakerless Inductive Discharge (BID)	6's & V-8's only (4's - BPI)
1977-1984	Motorcraft Solid State Ignition (SSI)	6's & V-8's only
1980-1983	Delco-Remy High Energy Ignition (HEI)	4's only
1984	Motorcraft SSI	All except 2.8 L, V-6
1984	Delco-Remy HEI	2.8 L V-6
CHRYSLER CORPORATION		
Thru 1972	Breaker Point Ignition (BPI)	Most*
1973-1983	Electronic Ignition System (EIS)	6's & V-8's only
1978-1984	Electronic Ignition System (EIS HALL) Electronic Spark Control System	Hall effect distributor (domestic 4 cyl.)
1981-1984	Electronic Ignition System Mitsubishi (EIS-MMC)	2.6 L 4 cyl. only
1976-1978	Electronic Lean Burn System (ELB)	Selected 6's and V-8's only
1978-1981	Electronic Spark Control System (ESC)	6's & V-8's only
1981-1984	Electronic Fuel Control System (EFCS)	6's & V-8's only

Table 5-1. Ignition System Identification (continued)

Manufacturer/ Year	Ignition System	Qualification
FORD MOTOR COMPANY		
Thru 1974	Breaker Point Ignition (BPI)	Most*
1974-1976	Motorcraft Solid State Ignition (SSI)	Most*
1977-1979	Dura Spark I (DS I)	Calif. only
1977-1984	Dura Spark II (DS II)	Check Vehicle Service Manual
1980-1984	Dura Spark III (DS III)	Check Vehicle Service Manual
1982-1984	Thick Film Ignition I (TFI-I)	Check Vehicle Service Manual
1983-1984	Thick Film Ignition IV (TFI-IV)	Check Vehicle Service Manual
GENERAL MOTORS		
Thru 1974	Breaker Point Ignition (BPI)	Most*
1974-1984	Delco-Remy High Energy Ignition (HEI) Two versions: 1. Integral coil system: all V-8's and most V-6's, some in-line 6's and 4's. 2. Externally mounted coil system: some in-line and V-6's & 4's.	All

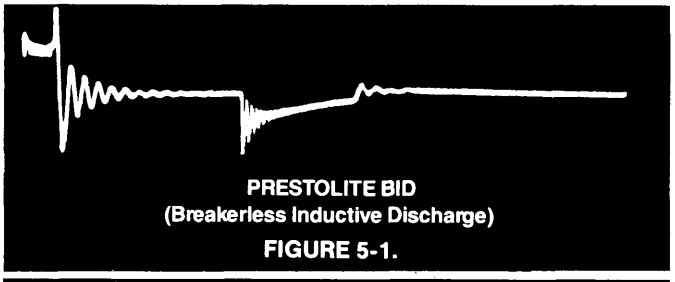
* The vast majority of these vehicles are breaker point; some High Performance models may use some form of electronic ignition. See your vehicle service manual for specifications.

Table 5.2 Oscilloscope Tests

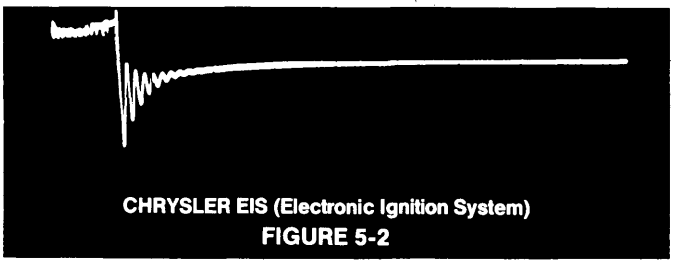
IGNITION SYSTEM	CHAPTER, SECTION, SUBJECT Ch.6 Spark Polarity	Ch. 7-I Max. Coil Output	7-II "	7-III "	Ch. 8-I Secondary Insulation	8-II "	8-III "	8-IV "	8-V "	Ch. 9-I Spark Voltage	9-II "	Ch. 10 Dwell and Variation	Ch. 11-I Coil/Condenser	11-II "	Ch. 12 Point Action	Ch. 13 Secondary Resistance	Ch. 14 Coil Output Cranking	Ch. 15-I Rotor Gap	15-II "	Ch. 16 Alternator Test	Ch. 17-I Magnetic Pickup Coil	17-II "	17-III "
Breaker Point	X	X			X					X		X	X		X	X	X	X		X			
Delco-Remy HEI	X		X			X					X	X		X		X			X	X	X		
Chrysler Electronic Ignition (EIS)	X	X					X			X						X		X		X		X	
EIS (MMC) Mitsubishi Motor Corporation	X	X					X			X				X				X		X			
EIS Domestic 4 cyl. (Hall Effect)	X	X					X			X				X		X		X		X			
Motor Craft Solid State Ignition (SSI)	X			X				X		X				X		X		X		X			X
DuraSpark I	X			X				X		X				X		X		X		X			X
DuraSpark II	X			X				X		X				X		X		X		X			X
DuraSpark III	X			X				X		X				X		X		X		X			
Thick Film Ignition I (TFI I)	X		X			X					X			X		X			X	X			
Thick Film Ignition IV TFI IV	X		X			X					X			X		X			X	X			
Prestolite Breakerless Inductive Discharge (BID)	X	X							X	X				X		X		X		X			

X indicates applicable Chapter.

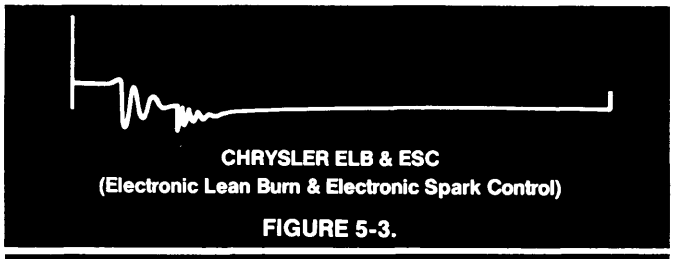
5-3. Waveshape Identification. Extensive use of illustrations has been made throughout this manual. Many of these are actual photographs of the waveshapes and patterns you will be observing. Due to the size reduction of many of the illustrations used, some waveshape detail has been reduced to the point where it is difficult to see. The following nine illustrations show this secondary oscillation detail clearly. Pick the illustration which matches your vehicles's ignition system and study it carefully. It is a good representation of what your scope should show you in this portion of the pattern, when the ignition system is functioning properly. The illustrations shown are most accurate with the engine running between 900-1400 RPM.



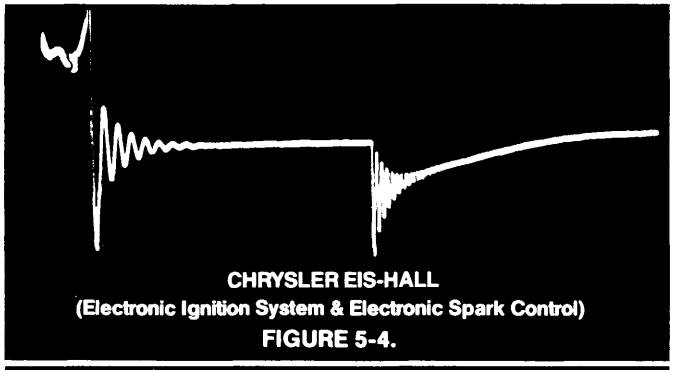
PRESTOLITE BID
(Breakerless Inductive Discharge)
FIGURE 5-1.



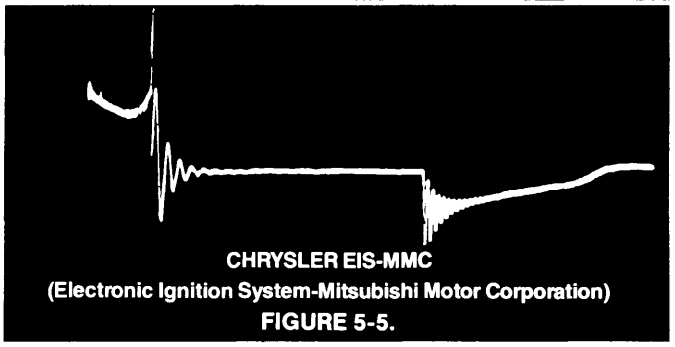
CHRYSLER EIS (Electronic Ignition System)
FIGURE 5-2



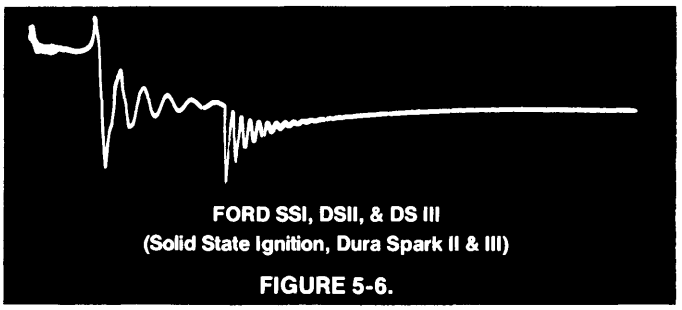
CHRYSLER ELB & ESC
(Electronic Lean Burn & Electronic Spark Control)
FIGURE 5-3.



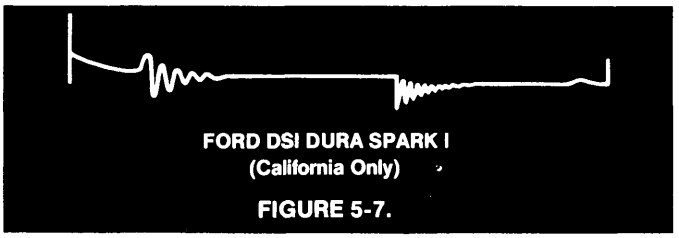
CHRYSLER EIS-HALL
(Electronic Ignition System & Electronic Spark Control)
FIGURE 5-4.



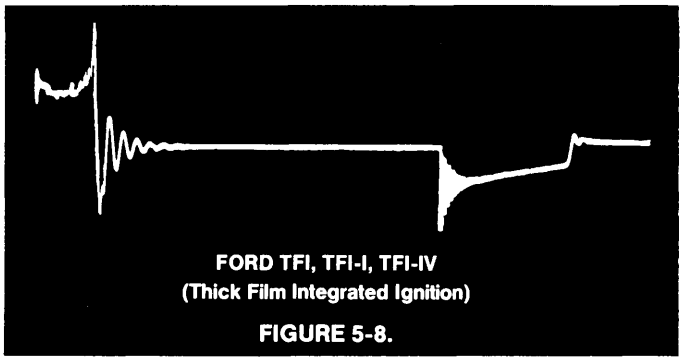
CHRYSLER EIS-MMC
(Electronic Ignition System-Mitsubishi Motor Corporation)
FIGURE 5-5.



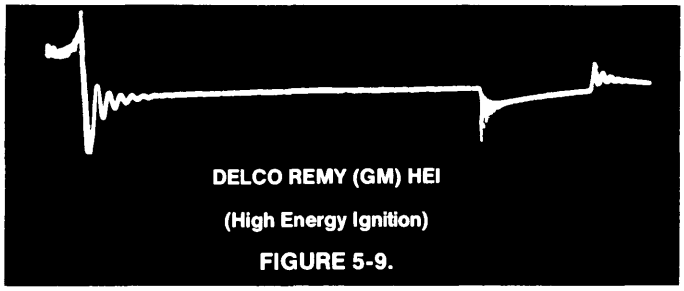
FORD SSI, DSII, & DS III
(Solid State Ignition, Dura Spark II & III)
FIGURE 5-6.



FORD DSI DURA SPARK I
(California Only)
FIGURE 5-7.



FORD TFI, TFI-I, TFI-IV
(Thick Film Integrated Ignition)
FIGURE 5-8.



DELCO REMY (GM) HEI
(High Energy Ignition)
FIGURE 5-9.

5-4. Ignition System Abbreviations

Please note that the following abbreviations regarding ignition systems will be used extensively throughout this manual.

1.	BPI	Breaker Point Ignition System
2.	EIS	Chrysler Electronic Ignition System (Domestic 6 & 8 cylinder engines)
3.	EIS-HALL	Chrysler Electronic Ignition System and Electronic Spark Control - HALL EFFECT 4 cylinder (Domestic)
4.	EIS-MMC	Chrysler Electronic Ignition System (Mitsubish
5.	ELB	Chrysler Electronic Lean Burn
6.	ESC	Chrysler Electronic Spark Control
7.	SSI	Motorcraft Solid State Ignition
8.	DS I	Ford Dura Spark I
9.	DS II	Ford Dura Spark II
10.	DS III	Ford Dura Spark III
11.	TFI	Ford Thick Film Integrated Ignition
12.	TFI-I	Ford Thick Film Integrated Ignition I
13.	TFI-IV	Ford Thick Film Integrated Ignition IV
14.	HEI	General Motors Delco-Remy High Energy Ign
15.	BID	Prestolite Breakerless Inductive Discharge

CHAPTER 6.
SPARK POLARITY TEST
ALL IGNITION SYSTEMS

6-1. DESCRIPTION. Incorrect polarity in the primary or secondary circuit can result in a greater voltage requirement to fire the spark plugs and may cause the engine to misfire under load or at high speed. This test checks for correct polarity in the entire ignition circuit.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

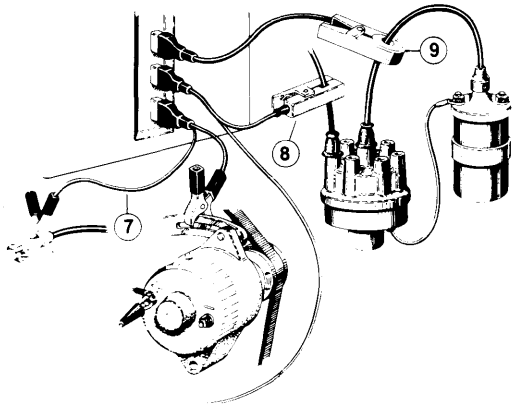
6-2. HOOK-UP PROCEDURE. Refer to Figure 6-1A, B or C. The scope controls and cables are numbered in Figure 6-1A, B or C as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connection.**
Make the following connections:

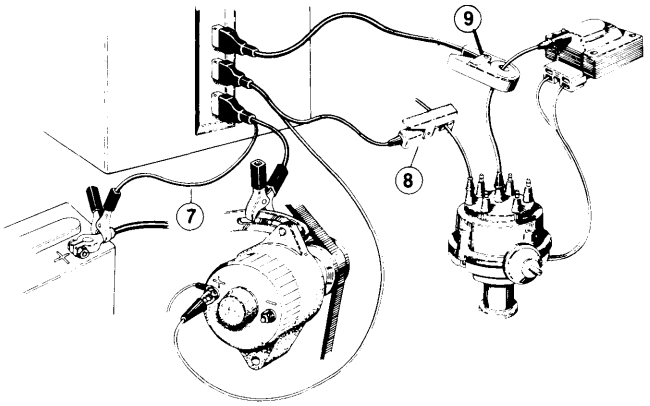
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the alternator bracket as shown in Figure 6-1A, B or C.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

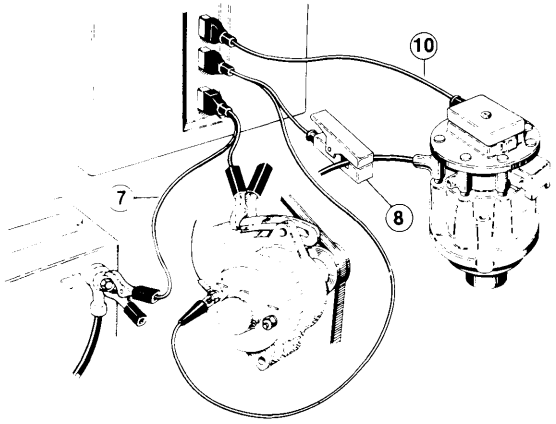


CYLINDRICAL COIL SYSTEMS
FIGURE 6-1A

SPARK POLARITY TEST
Hook Up



"E" CORE COIL SYSTEMS
(GM HEI, FORD TFI, TFI-I and IV)
FIGURE 6-1B.



INTEGRAL COIL (GM HEI)
FIGURE 6-1C.

SPARK POLARITY TEST
Hook Up

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

NOTE
In most HEI systems, the coil is mounted inside the distributor and requires the use of the HEI PATTERN CAPACITIVE PICK-UP (10) for this test. The following paragraphs provide hook-up instructions for both externally and internally mounted coils. Be sure to use the correct pick-up for the system being tested.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. CAPACITIVE PICK-UP (9). Use the CAPACITIVE PICK-UP (9) for all systems with the ignition coil mounted externally. Figure 6-1. A & B.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

2. HEI PATTERN CAPACITIVE PICK-UP (10). Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap). Figure 6-1C.
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   a. Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**
1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

6-3. TEST PROCEDURE.

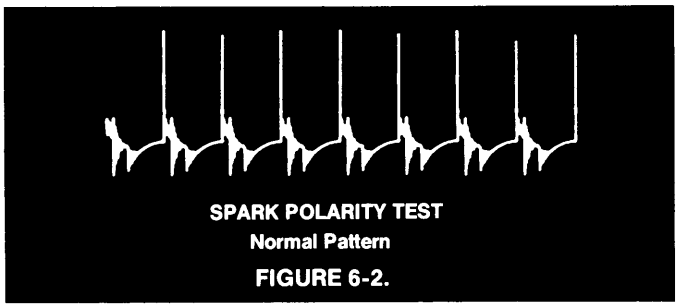
A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

B. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 6-2 and 6-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 6-2. The firing lines of the spark plug patterns should extend upward.

C. **Engine Off.** Turn vehicle engine off.

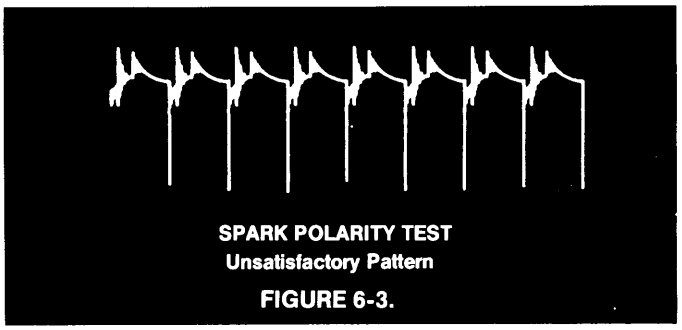
6-4. TEST RESULTS.

A. **Normal Pattern.** The firing lines of the spark plug patterns extend upward.



SPARK POLARITY TEST
Normal Pattern
FIGURE 6-2.

B. **Unsatisfactory Pattern.** The firing lines of the spark plug patterns extend downward.



SPARK POLARITY TEST
Unsatisfactory Pattern
FIGURE 6-3.

If an unsatisfactory pattern exists, check for:
a. Reversed coil connections.
b. Incorrect or defective coil.
c. Reversed battery connections.

CHAPTER 7.
MAXIMUM COIL OUTPUT TEST (AVAILABLE VOLTAGE)
SECTION: 1. BPI, EIS, EIS MMC, EIS HALL and BID Systems

7-1. DESCRIPTION. For any ignition system to function properly, the ignition coil must be able to produce a high secondary voltage. Failure of the ignition coil to produce adequate voltage may cause the engine to misfire under load or at high speed. The maximum secondary voltage produced by an ignition coil can be measured in this test to ensure adequate voltage.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

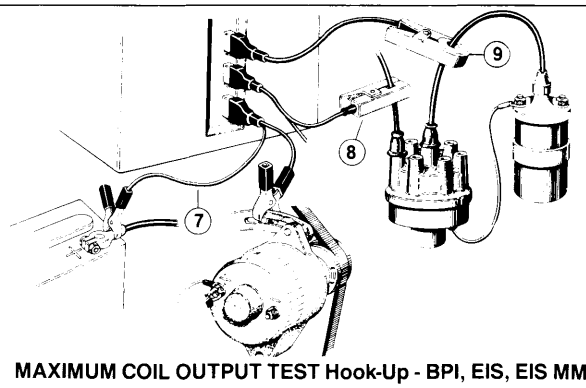
CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

7-2. HOOK-UP PROCEDURE. Refer to figure 7-1. The scope controls and cables are numbered in figure 7-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, figure 2-1, table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the alternator bracket as shown in Figure 7-1.



MAXIMUM COIL OUTPUT TEST Hook-Up - BPI, EIS, EIS MMC, EIS HALL, BID.
FIGURE 7-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically, 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

7-3. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP (8) should be clamped to the No. 1 spark plug wire as instructed above in paragraph 7-2.D.

D. **Engine On.** Start vehicle engine.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 7-2 and 7-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 7-2. (The pattern illustrated is for BPI. Oscillation detail on electronic ignition systems will vary as shown in Chapter 5.)

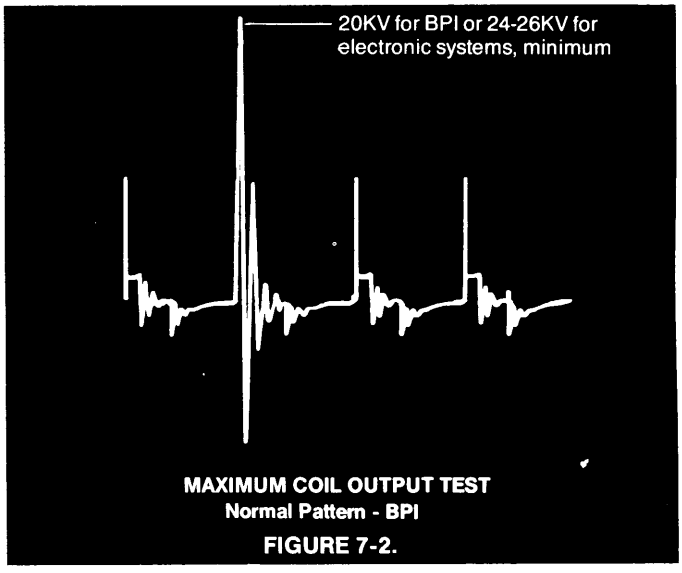
F. **Engine Off.** Turn vehicle engine off.

G. **Reconnect.** Reconnect spark plug wire.

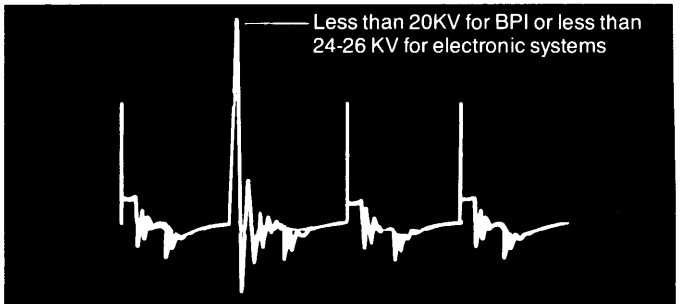
7-4. TEST RESULTS.

A. **Normal Pattern.** The secondary voltage available for the disconnected spark plug should be greater than 20 KV for Breaker Point Systems or approximately 24-26 KV for Electronic Ignition Systems as read on the 50 Kilovolt scale. If a satisfactory pattern exists, both the primary and secondary circuits are operating normally.

B. **Unsatisfactory Pattern.** An unsatisfactory pattern shows a maximum available voltage of less than 20 KV on the Breaker Point System or approximately 24-26 KV on the electronic systems as displayed on the Kilovolt Scale.



MAXIMUM COIL OUTPUT TEST
Normal Pattern - BPI
FIGURE 7-2.



MAXIMUM COIL OUTPUT TEST
Unsatisfactory Pattern - BPI
FIGURE 7-3.

If an unsatisfactory pattern exists, check for:

a. Defective coil.
b. Defective coil wire.
c. Low battery voltage.
d. Dwell much lower than specified. (Does not apply to electronic ignition systems)
e. Excessive resistance in primary circuit, reducing input to ignition coil.
f. Defective secondary insulation on ignition wires.
g. Defective condenser.
h. Defective rotor and/or distributor cap.
i. Defective ignition module. (Electronic ignition systems only.)

SECTION II. GM HEI, FORD TFI, TFI-I, TFI-IV Systems

7-5. DESCRIPTION. For any ignition system to function properly, the ignition coil must be able to produce a high secondary voltage. Failure of the ignition coil to produce adequate voltage may cause the engine to misfire under load or at high speed. The maximum secondary voltage produced by an ignition coil can be measured in this test to ensure adequate voltage.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

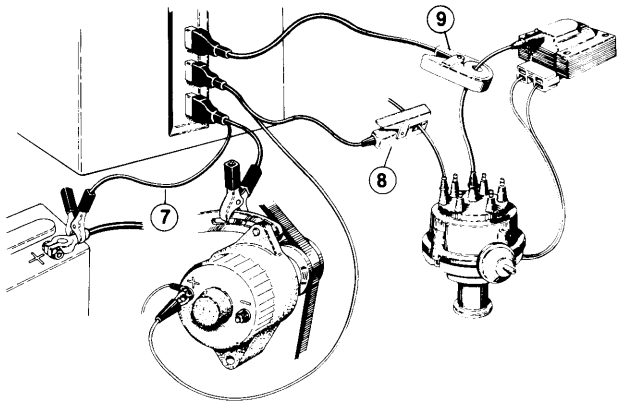
7-6. HOOK-UP PROCEDURE. Refer to Figure 7-4A or B. The scope controls and cables are numbered in Figure 7-4 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper

hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

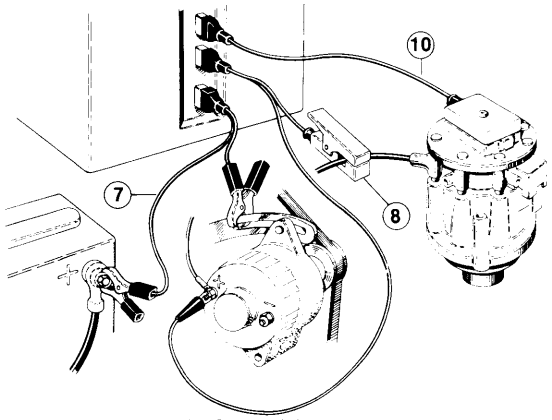
A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the alternator bracket as shown in Figure 7-4.



"E" CORE COIL SYSTEMS
(GM HEI, FORD TFI, TFI-I and IV)
FIGURE 7-4A.



INTEGRAL COIL GM HEI
FIGURE 7-4B.

MAXIMUM COIL OUTPUT TEST Hook-Up - GM HEI, TFI

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely enclosed clamps may cause mistriggering and/or faulty calibration of scope patterns.

NOTE

In some HEI systems, the coil is mounted in the distributor and requires the use of the HEI PATTERN CAPACITIVE PICK-UP (10) for this test. The following paragraphs provide hook-up instructions for both externally and internally mounted coils. Be sure to use the correct pick-up for the system being tested.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. **CAPACITIVE PICK-UP (9).** Use the CAPACITIVE PICK-UP (9) for HEI and TFI systems with the ignition coil mounted externally. Figure 7-4A.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.
2. **HEI PATTERN CAPACITIVE PICK-UP (10).** Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap). Figure 7-4B.
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   a. Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON, the switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically, 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.

2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

7-7. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

CAUTION

Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.

DO NOT DISCONNECT:

V-8 engines:	No. 1 or No. 8 spark plug wire.
V-6 engines:	No. 1 or No. 4 spark plug wire.
I-6 engines:	No. 3 or No. 5 spark plug wire.
4-Cylinder engines:	No. 1 or No. 3 spark plug wire.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 7-6.D.

D. **Engine On.** Start vehicle engine.

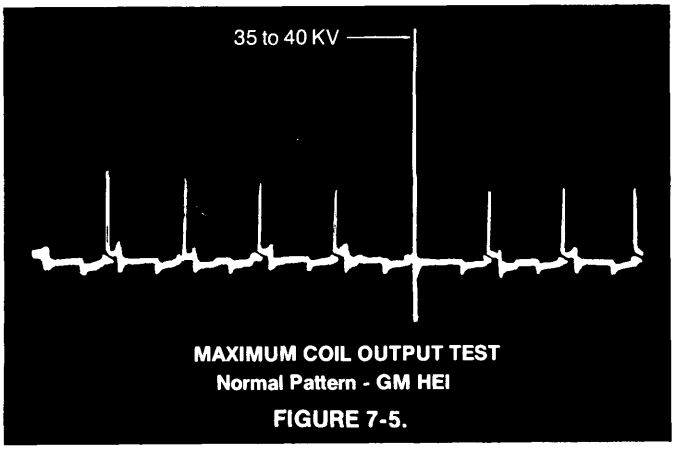
E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 7-5 and 7-6. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 7-5. (The pattern illustrated is for the GM HEI system. Oscillation detail on the TFI system may be different, refer to chapter 5).

F. **Engine Off.** Turn vehicle engine off.

G. **Reconnect.** Reconnect spark plug wire.

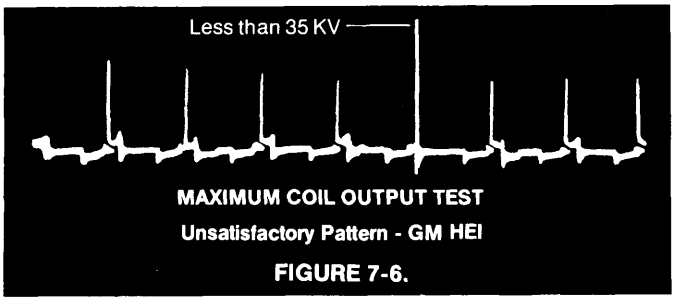
7-8. TEST RESULTS.

A. **Normal Pattern.** The secondary voltage available for the disconnected spark plug should be greater than 35 KV on GM HEI and 40 KV on Ford TFI systems as read on the 50 Kilovolt scale. If a satisfactory pattern exists, both the primary and secondary circuits are operating normally.



MAXIMUM COIL OUTPUT TEST
Normal Pattern - GM HEI
FIGURE 7-5.

B. **Unsatisfactory Pattern.** An unsatisfactory pattern shows a maximum available voltage of significantly less than 35 KV on the Kilovolt scale.



MAXIMUM COIL OUTPUT TEST
Unsatisfactory Pattern - GM HEI
FIGURE 7-6.

If an unsatisfactory pattern exists, check for:

a. Defective coil.
b. Low battery voltage.
c. Excessive resistance in primary circuit, reducing input to ignition coil.
d. Defective secondary insulation on ignition wires.
e. Defective ignition module.
f. Defective rotor and/or distributor cap.

SECTION III. FORD SSI, DS SYSTEMS

7-9. DESCRIPTION. For any ignition system to function properly, the ignition coil must be able to produce a high secondary voltage. Failure of the ignition coil to produce adequate voltage may cause the engine to misfire under load or at high speed. The maximum secondary voltage produced by an ignition coil can be measured in this test to ensure adequate voltage.

CAUTION

Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION

Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION

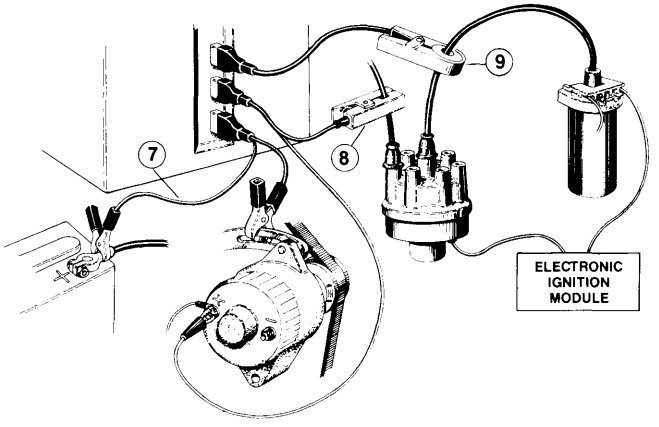
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

7-10. HOOK-UP PROCEDURE. Refer to Figure 7-7. The scope controls and cables are numbered in Figure 7-7 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 7-7.



MAXIMUM COIL OUTPUT TEST Hook-Up - SSI, DS Systems

FIGURE 7-7.

CAUTION

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration or scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**

1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counter-clockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

7-11. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

CAUTION

Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.

DO NOT DISCONNECT:

V-8 engines:	No. 1 or No. 8 spark plug wire.
V-6 engines:	No. 1 or No. 4 spark plug wire.
I-6 engines:	No. 3 or No. 5 spark plug wire.
4-Cylinder engines:	No. 1 or No. 3 spark plug wire.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire

with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 7-10.D.

D. **Engine On.** Start vehicle engine.

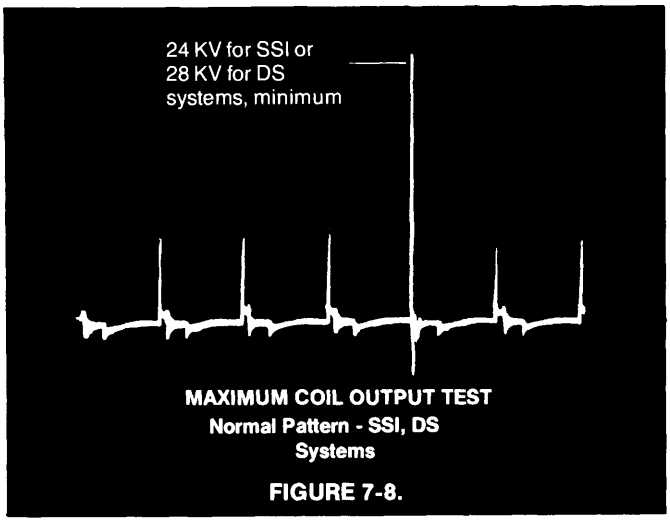
E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 7-8 and 7-9. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 7-8.

F. **Engine Off.** Turn vehicle engine off.

G. **Reconnect.** Reconnect spark plug wire.

7-12. TEST RESULTS

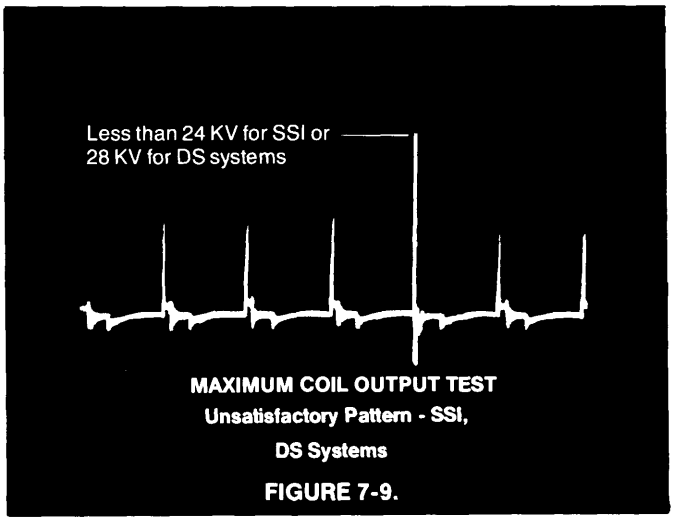
A. **Normal Pattern.** The secondary voltage available for the disconnected spark plug should be greater than 24 KV for the SSI system or 28 KV for the DS systems as read on the 50 Kilovolt scale. If a satisfactory pattern exists, both the primary and secondary circuits are operating normally.



MAXIMUM COIL OUTPUT TEST
Normal Pattern - SSI, DS Systems

FIGURE 7-8.

B. **Unsatisfactory Pattern.** An unsatisfactory pattern shows a maximum available voltage of less than 24 KV on the SSI System or 28 KV on the DS Systems as displayed on the 50 Kilovolt scale.



MAXIMUM COIL OUTPUT TEST
Unsatisfactory Pattern - SSI, DS Systems

FIGURE 7-9.

If an unsatisfactory pattern exists, check for:

a. Defective coil.
b. Defective coil wire.
c. Low battery voltage.
d. Excessive resistance in primary circuit, reducing input to ignition coil.
e. Defective secondary insulation.
f. Defective ignition module.

CHAPTER 8
SECONDARY INSULATION TEST
SECTION I. BPI System

8-1. DESCRIPTION. The secondary ignition circuit is the path of voltage from the coil to the gap of the spark plugs' electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

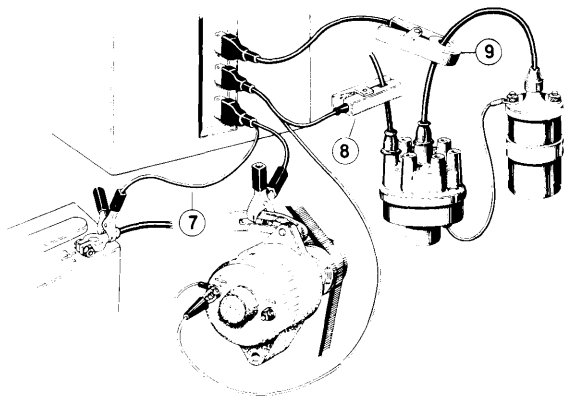
CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

8-2. HOOK-UP PROCEDURE. Refer to Figure 8-1. The scope controls and cables are numbered in Figure 8-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 8-1.



SECONDARY INSULATION TEST Hook-Up - BPI
FIGURE 8-1

CAUTION
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A break with the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

8-3. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug (see I. below). Do not move a loose spark plug wire out of normal operating position, but keep it from grounding. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 8-2.D.

D. **Engine On.** Start vehicle engine.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 8-2 and 8-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 8-2.

F. **Engine Off.** Turn vehicle engine off.

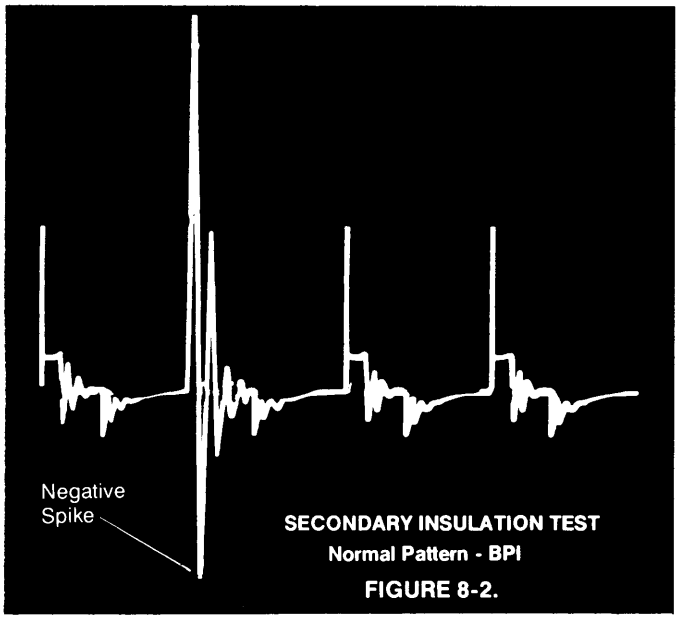
G. **Reconnect.** Reconnect spark plug wire.

H. **Test Remaining Spark Plug Wires.** Repeat the test procedure with each spark plug wire, except the wire leading to the first spark plug in the firing order (see next step). Make a note of which cylinder patterns are normal and which are unsatisfactory.

I. **Test No. 1 Spark Plug Wire.** To test the No. 1 spark plug wire, move the INDUCTIVE PICK-UP to a spark plug wire that has already been tested satisfactorily. Disconnect and test the No. 1 spark plug wire.

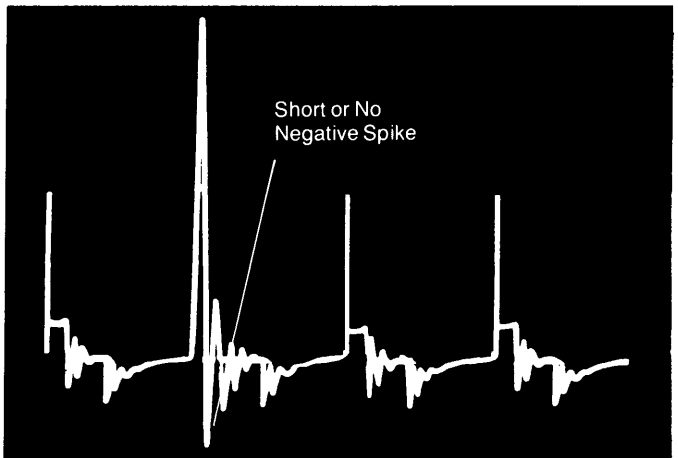
8-4. TEST RESULTS.

A. **Normal Pattern.** The downspike of the pattern for the disconnected spark plug should be approximately half as long as the upward spike of the pattern, as illustrated in Figure 8-2. If this pattern is displayed, the secondary insulation is satisfactory.



SECONDARY INSULATION TEST
Normal Pattern - BPI
FIGURE 8-2.

B. **Unsatisfactory Pattern.** If the pattern displayed shows a short or no downspike for the disconnected spark plug, as illustrated in Figure 8-3, there is a secondary insulation problem.



SECONDARY INSULATION TEST
Unsatisfactory Pattern - BPI
FIGURE 8-3.

1. If an unsatisfactory pattern exists for all spark plugs/cylinders, check for:
   a. Cracked or carbon tracking of the coil tower.
   b. Defective coil wire.
   c. Cracked or carbon tracking of the rotor.
   d. Cracked or carbon tracking of the center tower of distributor cap.
2. If one or more, but not all, spark plugs/cylinders test unsatisfactorily, check for:
   a. Cracked or carbon tracking of one or more of the distributor cap towers.
   b. Defective spark plug wires. Refer to step three below for instructions on testing individual spark plug wires.
3. **Defective Spark Plug Wire Test.** If the above test results indicate faulty spark plug wires, perform the following procedure to determine which spark plug wires are defective.
   a. Select the first wire that produced an unsatisfactory pattern in the test above, and disconnect the wire at the distributor cap.
   b. Perform the Secondary Insulation Test for this spark plug wire.
   c. If the pattern for this spark plug is unsatisfactory when tested with the spark plug end disconnected, and is satisfactory with distributor cap end disconnected, the spark plug wire is defective.
   d. Repeat steps a through c for each spark plug wire that tested unsatisfactorily in the Secondary Insulation Test with the plug end disconnected.

SECTION II. GM HEI, Ford TFI, TFI-I, TFI-IV Systems

8-5. DESCRIPTION. The secondary ignition circuit is the path of voltage from the coil to the gap of the spark plugs' electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead

of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

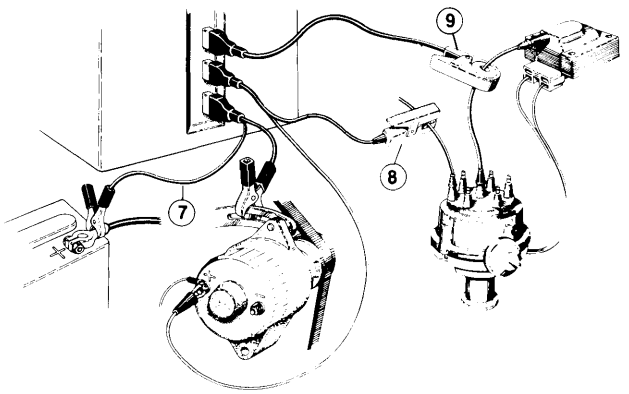
CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

8-6. **HOOK-UP PROCEDURE.** Refer to Figure 8-4 A or B. The scope controls and cables are numbered in Figure 8-4 A and B as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2 Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

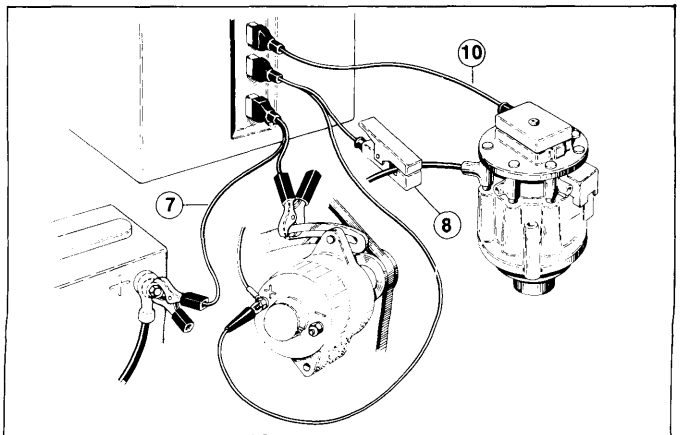
B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 8-4.



"E" CORE COIL SYSTEMS
(GM HEI, FORD TFI, TFI-I and IV)
FIGURE 8-4A.
SECONDARY INSULATION TEST Hook-Up - GM HEI, Ford TFI

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



INTEGRAL COIL (HEI)
FIGURE 8-4B.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

NOTE: In some HEI systems, the coil is mounted inside the distributor and requires the use of the HEI PATTERN CAPACITIVE PICK-UP (10) for this test. The following paragraphs provide hook-up instructions for both externally and internally mounted coils. Be sure to use the correct pick-up for the system being tested.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. **CAPACITIVE PICK-UP (9).** Use the CAPACITIVE PICK-UP (9) for HEI and TFI systems with the ignition coil mounted externally. Figure 8-4A.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.
2. **HEI PATTERN CAPACITIVE PICK-UP (10).** Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap). Figure 8-4B.
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.

2. Turn PATTERN LENGTH CONTROL (6) counter-clockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire being tested with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

8-7. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

> **CAUTION**
> Do not disconnect spark plug wires at the distributor during testing on the HEI systems.

> **CAUTION**
> Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.
>
> DO NOT DISCONNECT:
>
> | | |
> |---|---|
> | V-8 engines: | No. 1 or No. 8 spark plug wire. |
> | V-6 engines: | No. 1 or No. 4 spark plug wire. |
> | I-6 engines: | No. 3 or No. 5 spark plug wire. |
> | 4-Cylinder engines: | No. 1 or No. 3 spark plug wire. |

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 8-6.D.

D. **Engine On.** Start vehicle engine.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 8-5 and 8-6. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 8-5. (The pattern illustrated is the GM HEI system. Oscillation detail on the TFI system may be different. Refer to chapter 5.)

F. **Engine Off.** Turn vehicle engine off.

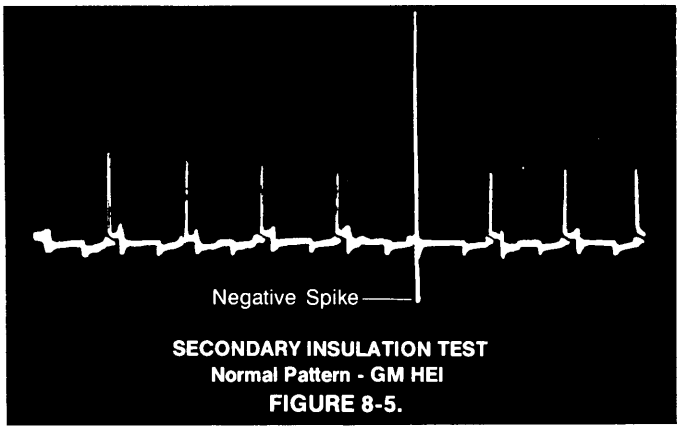
G. **Reconnect.** Reconnect spark plug wire.

H. **Test Remaining Spark Plug Wires.** Repeat the test procedure with each spark plug wire, except the wire leading to the No. 1 spark plug (see next step). Remember **not** to disconnect wires indicated after Step 8-7B. Make a note of which cylinder patterns are normal and which are unsatisfactory.

I. **Test No. 1 Spark Plug Wire.** To test the No. 1 spark plug wire, move the INDUCTIVE PICK-UP to a spark plug wire that has already been tested satisfactorily. Disconnect and test the No. 1 spark plug wire when allowable.

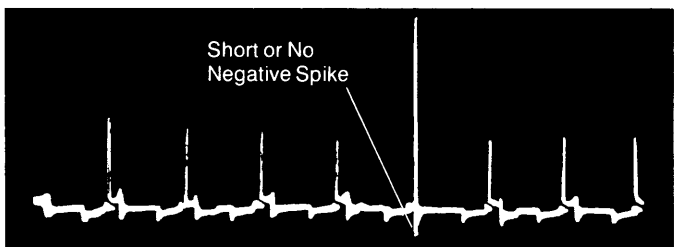
8-8. TEST RESULTS.

A. **Normal Pattern.** The downspike of the pattern for the disconnected spark plug should be approximately one quarter as long as the upward spike of the pattern, as illustrated in Figure 8-5. If this pattern is displayed, the secondary insulation is satisfactory.



SECONDARY INSULATION TEST
Normal Pattern - GM HEI
FIGURE 8-5.

B. **Unsatisfactory Pattern.** If the pattern displayed shows a short or no downspike for the disconnected spark plug, as illustrated in Figure 8-6, there is a secondary insulation problem.



SECONDARY INSULATION TEST
Unsatisfactory Pattern - GM HEI
FIGURE 8-6.

1. If an unsatisfactory pattern exists for all spark plugs/cylinders, check for:
   a. Cracked or carbon tracking of the rotor.
   b. Coil Tower Brush (Integral Coil HEI)
2. If one or more, but not all, spark plugs/cylinders test unsatisfactorily, check for:
   a. Cracked or carbon tracking of the distributor cap towers.
   b. Defective spark plug wires. Refer to step three below for instructions on testing individual spark plug wires.
3. Defective Spark Plug Wire Test. If the above test results indicate faulty spark plug wires, perform the following procedure to determine which spark plug wires are defective.
   a. Replace one spark plug wire at a time with a known good wire until the defective one(s) is found.
   b. Repeat Secondary Insulation Test.

SECTION III. EIS (ALL CHRYSLER SYSTEMS)

8-9. DESCRIPTION The secondary ignition circuit is the path of voltage from the coil to the gap of each spark plug's electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

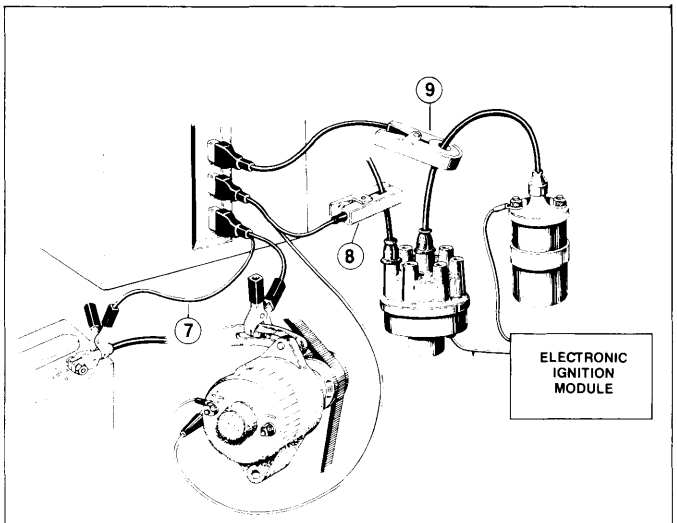
CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

8-10. HOOK-UP PROCEDURE. Refer to Figure 8-7. The scope controls and cables are numbered in Figure 8-7 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 8-7.



SECONDARY INSULATION TEST Hook-Up - EIS

FIGURE 8-7.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACTIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   a. Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.

2. Turn PATTERN LENGTH CONTROL (6) counter-clockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

8-11. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 plug (see I. below). Do not move a loose spark plug wire out of normal operating position, but keep it from arcing to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 8-10.D.

D. **Engine On.** Start vehicle engine.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 8-8 and 8-9. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 8-8.

F. **Engine Off.** Turn vehicle engine off.

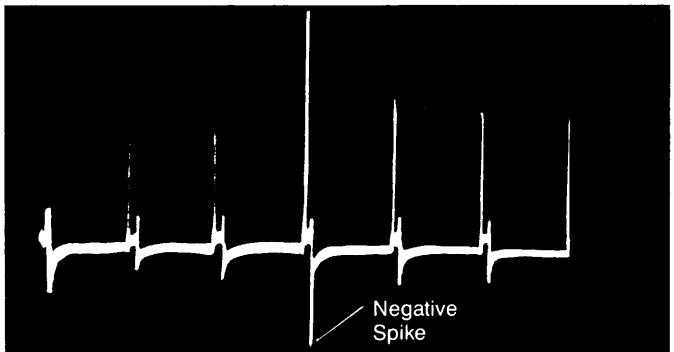
G. **Reconnect.** Reconnect spark plug wire.

H. **Test Remaining Spark Plug Wires.** Repeat the test procedure with each spark plug wire, except the wire leading to the No. 1 spark plug (see next step). Make a note of which cylinder patterns are normal and which are unsatisfactory.

I. **Test No. 1 Spark Plug Wire.** To test the No. 1 spark plug wire, move the INDUCTIVE PICK-UP to a spark plug wire that has already been tested satisfactorily. Disconnect and test the No. 1 spark plug wire.

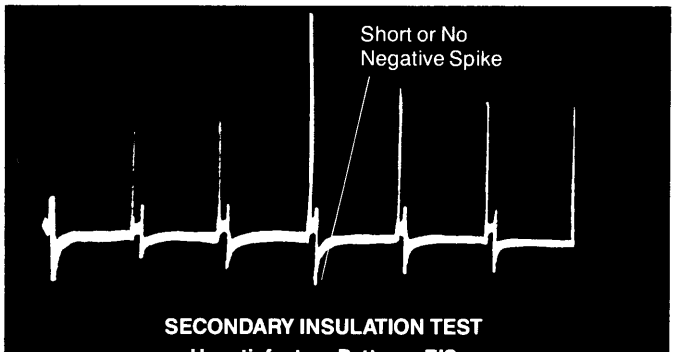
8-12. TEST RESULTS.

A. **Normal Pattern.** The normal basic scope pattern of the spark plugs for the Chrysler Electronic Ignition System, 6 and 8 cylinder (domestic only) does not have a coil/condenser action section. Refer to Figure 8-8. Refer to Chapter 5 for oscillation detail on all remaining Chrysler Systems. Under the secondary insulation test, the downspike of the pattern for the disconnected spark plug should be approximately one third as long as the upward spike of the pattern, as illustrated in Figure 8-8. If this pattern is displayed, the secondary insulation is satisfactory.



SECONDARY INSULATION TEST
Normal Pattern - EIS
FIGURE 8-8.

B. **Unsatisfactory Pattern.** If the pattern displayed shows a short or no downspike for the disconnected spark plug, as illustrated in Figure 8-9, there is a secondary insulation problem.



SECONDARY INSULATION TEST
Unsatisfactory Pattern - EIS
FIGURE 8-9

1. If an unsatisfactory pattern exists for all spark plugs/cylinders, check for:
   a. Cracked or carbon tracking of the coil tower.
   b. Defective coil wire.
   c. Cracked or carbon tracking of the rotor.
   d. Cracked center tower or carbon tracking of the distributor cap.
2. If one or more, but not all, spark plugs/cylinders test unsatisfactorily, check for:
   a. Cracked or carbon tracking of the distributor cap towers.
   b. Defective spark plug wires. Refer to step three below for instructions on testing individual spark plug wires.

3. Defective Spark Plug Wire Test. If the above test results indicate faulty spark plug wires, perform the following procedure to determine which spark plug wires are defective.

CAUTION
Most Chrysler domestic 4 cylinder engines use a "positive locking" terminal electrode spark plug wire that can be removed only from the **INSIDE** of the distributor cap. Damage may result to the components if other means of removal are attempted. Refer to your service manual.

a. Select the first wire that produced an unsatisfactory pattern in the test above, and disconnect the wire at the distributor cap.
b. Perform the Secondary Insulation Test for this spark plug wire.
c. If the pattern for this spark plug is unsatisfactory when tested with the spark plug end disconnected, and is satisfactory with distributor cap end disconnected, the spark plug wire is defective.
d. Repeat steps a through c for each spark plug wire that tested unsatisfactorily in the Secondary Insulation Test with the plug end disconnected.

SECTION IV. FORD SSI, DS SYSTEMS

8-13. DESCRIPTION The secondary ignition circuit is the path of voltage from the coil to the gap of each spark plug's electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

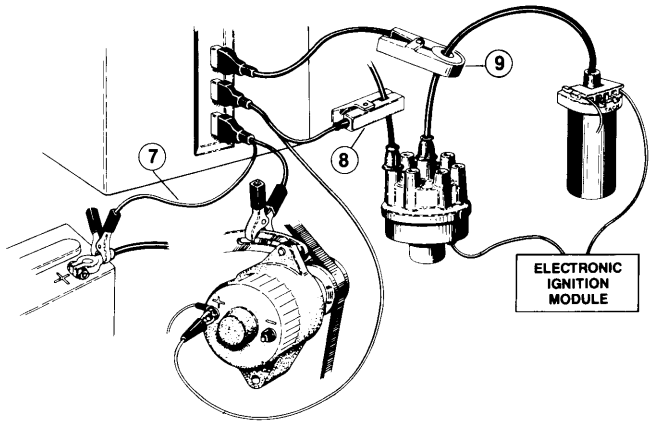
CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

8-14. HOOK-UP PROCEDURE. Refer to figure 8-10. The scope controls and cables are numbered in figure 8-10 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, figure 2-1, table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connection.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 8-10.



SECONDARY INSULATION TEST Hook-Up - SSI & DS Systems

FIGURE 8-10

CAUTION
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900-1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

8-15. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

> **CAUTION**
> Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.
>
> DO NOT DISCONNECT:
>
> | | |
> |---|---|
> | V-8 engines: | No. 1 or No. 8 spark plug wire. |
> | V-6 engines: | No. 1 or No. 4 spark plug wire. |
> | I-6 engines: | No. 3 or No. 5 spark plug wire. |
> | 4-Cylinder engines: | No. 1 or No. 3 spark plug wire. |

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 8-14.D.

D. **Engine On.** Start vehicle engine.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 8-11 and 8-12. The pattern displayed on the scope screen should match the normal pattern illustrated in figure 8-11.

F. **Engine Off.** Turn vehicle engine off.

G. **Reconnect.** Reconnect spark plug wire.

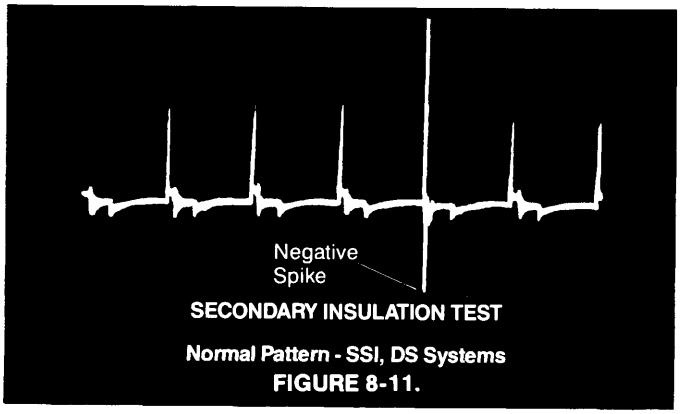
H. **Test Remaining Spark Plug Wires.** Repeat the test procedure with each spark plug wire, except the wire leading to the first spark plug in the firing order (see next step).

Make a note of which cylinder patterns are normal and which are unsatisfactory.

I. **Test No. 1 Spark Plug Wire.** To test the No. 1 spark plug wire where permissible according to the chart above, move the INDUCTIVE PICKUP to a spark plug wire that has already been tested satisfactorily. Disconnect and test the No. 1 spark plug wire.

8-16. TEST RESULTS.

A. **Normal Pattern.** The downspike of the pattern for the disconnected spark plug should be approximately one third as long as the upward spike of the pattern, as illustrated in Figure 8-11. If this pattern is displayed, the secondary insulation is satisfactory.

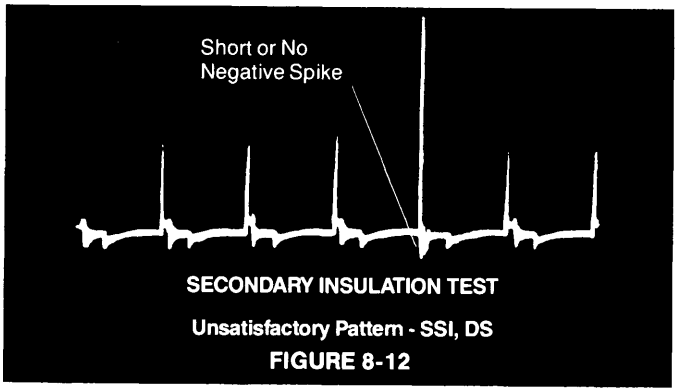


SECONDARY INSULATION TEST

Normal Pattern - SSI, DS Systems

FIGURE 8-11.

B. **Unsatisfactory Pattern.** If the pattern displayed shows a short or no donwspike for the disconnected spark plug, as illustrated in Figure 8-12, there is a secondary insulation problem.



SECONDARY INSULATION TEST

Unsatisfactory Pattern - SSI, DS

FIGURE 8-12

1. If an unsatisfactory pattern exists for all spark plugs/cylinders, check for:
   a. Cracked or carbon tracking in the coil tower.
   b. Defective coil wire.
   c. Cracked or carbon tracking in the rotor.
   d. Cracked or carbon tracking in the center tower of distributor cap.
2. If one or more, but not all, spark plugs/cylinders test unsatisfactorily, check for:
   a. Cracked or carbon tracking in the distributor cap towers.

b. Defective spark plug wires. Refer to step three below for instructions on testing individual spark plug wires.

3. Defective Spark Plug Wire Test. If the above test results indicate faulty spark plug wires, perform the following procedure to determine which spark plug wires are defective.
   a. Select the first wire that produced an unsatisfactory pattern in the test above, and disconnect the wire at the distributor cap.
   b. Perform the Secondary Insulation Test for this spark plug wire.
   c. If the pattern for this spark plug is unsatisfactory when tested with the spark plug end disconnected, and is satisfactory with distributor cap end disconnected, the spark plug wire is defective.
   d. Repeat steps a through c for each spark plug wire that tested unsatisfactorily in the Secondary Insulation Test with the plug end disconnected.

SECTION V. BID System

8-17. DESCRIPTION The secondary ignition circuit is the path of voltage from the coil to the gap of each spark plug's electrodes. This test checks the secondary ignition circuit for proper insulation. A break in the insulation of the secondary circuit will cause voltage to arc to ground instead of to the corresponding spark plug and cylinder. This results in the misfire of the spark plug.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

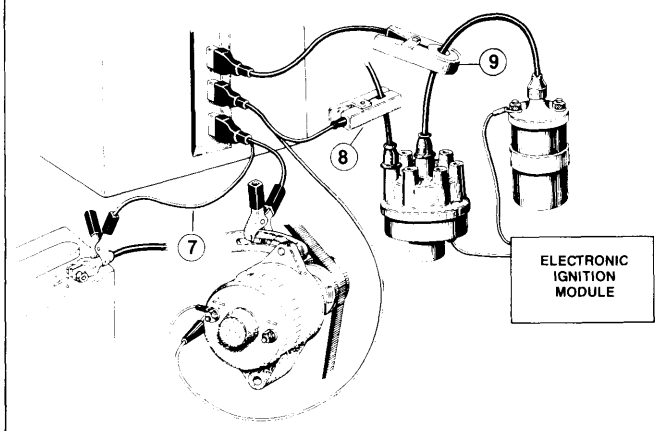
CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

8-18. HOOK-UP PROCEDURE. Refer to Figure 8-13. The scope controls and cables are numbered in Figure 8-13 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 8-13.



SECONDARY INSULATION TEST Hook-Up - BID

FIGURE 8-13

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

8-19. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug (see I. below). Do not move a loose spark plug wire out of normal operating position, but keep it from arcing to ground. The INDUCTIVE PICK-UP should be clamped to the first in firing order spark plug wire as instructed above in paragraph 8-18.D.

D. **Engine On.** Start vehicle again.

E. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 8-14 and 8-15. the pattern displayed on the scope screen should match the normal pattern illustrated in Figure 8-14.

F. **Engine Off.** Turn vehicle engine off.

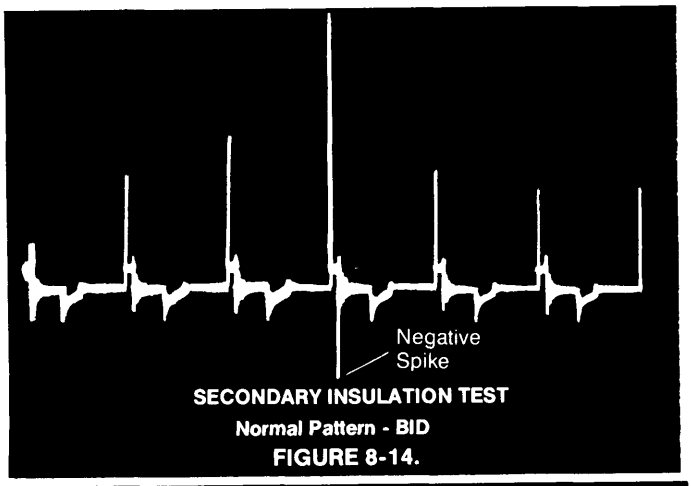
G. **Reconnect.** Reconnect spark plug wire.

H. **Test Remaining Spark Plug Wires.** Repeat the test procedure with each spark plug wire, except the wire leading to the first spark plug in the firing order (see next step). Make a note of which cylinder patterns are normal and which are unsatisfactory.

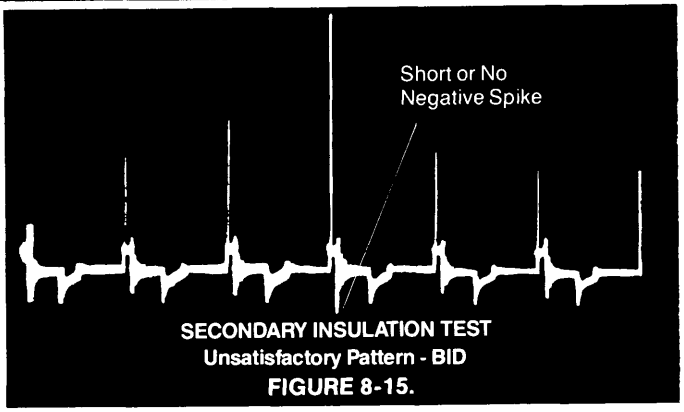
I. **Test No. 1 Spark Plug Wire.** To test the No. 1 spark plug wire, move the INDUCTIVE PICK-UP to a spark plug wire that has already been tested satisfactorily. Disconnect and test the No. 1 spark plug wire.

8-20. TEST RESULTS.

A. **Normal Pattern.** The normal basic scope pattern of the spark plug for the Prestolite BID Ignition System has an extra waveform in dwell section. Refer to Figure 8-14. The downspike of the pattern for the disconnected spark plug should be approximately one third as long as the upward spike of the pattern, as illustrated in Figure 8-14. If this pattern is displayed, the secondary insulation is satisfactory.



SECONDARY INSULATION TEST
Normal Pattern - BID
FIGURE 8-14.



SECONDARY INSULATION TEST
Unsatisfactory Pattern - BID
FIGURE 8-15.

B. **Unsatisfactory Pattern.** If the pattern displayed shows a short or no downspike for the disconnected spark plug, as illustrated in Figure 8-15, there is a secondary insulation problem.

1. If an unsatisfactory pattern exists for all spark plugs/cylinders, check for:
   a. Cracked or carbon tracking in the coil tower.
   b. Defective coil wire.
   c. Cracked or carbon tracking in the rotor.
   d. Cracked or carbon tracking in the center tower of the distributor cap.
2. If one or more, but not all, spark plugs/cylinders test unsatisfactorily, check for:
   a. Cracked or carbon tracking in the distributor cap towers.
   b. Defective spark plug wires. Refer to step three below for instructions on testing individual spark plug wires.
3. Defective Spark Plug Wire Test. If the above test results indicate faulty spark plug wires, perform the following procedure to determine which spark plug wires are defective.
   a. Select the first wire that produced an unsatisfactory pattern in the test above, and disconnect the wire at the distributor cap.
   b. Perform the Secondary Insulation Test for this spark plug wire.
   c. If the pattern for this spark plug is unsatisfactory when tested with the spark plug end disconnected, and is satisfactory with distributor cap end disconnected, the spark plug wire is defective.
   d. Repeat steps a through c for each spark plug wire that tested unsatisfactorily in the Secondary Insulation Test with the plug end disconnected.

CHAPTER 9.
SPARK VOLTAGE UNDER LOAD TEST
SECTION I. BPI, ALL CHRYSLER, FORD SSI & DS, AND PRESTOLITE BID SYSTEMS

9-1. DESCRIPTION. The spark voltage of all cylinders should be fairly uniform and rise slightly when the engine is snap accelerated. This test measures and compares the voltage requirements of each cylinder in an engine under load to determine if any faults are present.

CAUTION

Do not let test cables rest or fall on or near hot or moving engine parts.

9-2. HOOK-UP PROCEDURE. Refer to Figure 9-1. The scope controls and cables are numbered in Figure 9-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

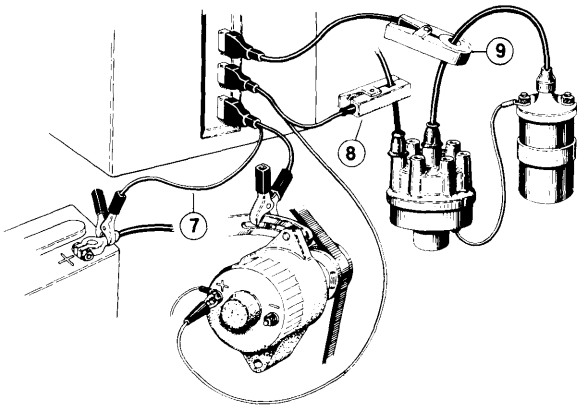
B. **POWER LEAD Connections.**

Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 9-1.

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



SPARK VOLTAGE UNDER LOAD TEST Hook-UP
FIGURE 9-1.

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**

1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 25 KV SPARK POSITION.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

9-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 25 KV SPARK VOLTAGE POSITION.

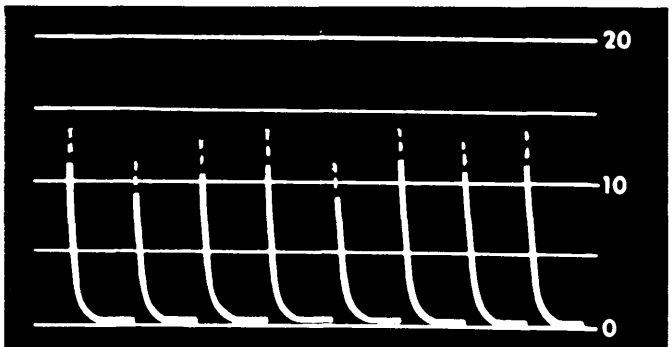
B. **Accelerate Engine.** Snap accelerate the engine by quickly depressing the accelerator pedal and then releasing it. Allow the engine to return to idle between accelerations. Do not hold the accelerator pedal down. A snap acceleration is a very rapid push-release of the accelerator pedal.

C. **Check Pattern.** During snap acceleration, compare the voltage pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 9-2 and 9-3.

D. **Engine Off.** Turn vehicle engine off.

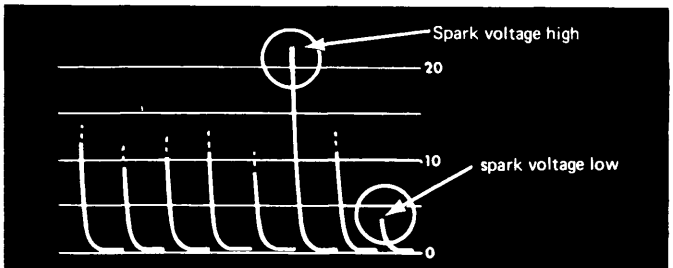
9-4. TEST RESULTS.

A. **Normal Pattern.** All spark voltages should be fairly uniform and increase slightly (1-2 KV) during snap acceleration. Engines designed to operate with a large rotor gap will display less pronounced variations in the patterns.



SPARK VOLTAGE UNDER LOAD TEST
Normal Pattern
FIGURE 9-2.

B. **Unsatisfactory Pattern.** A fault exists if the spark voltages are not uniform or if the voltage increase is either too small or too great.



SPARK PLUG VOLTAGE TEST
Unsatisfactory Pattern
FIGURE 9-3.

1. If all voltages are uniform but high, check for:
   a. Worn or widely gapped spark plugs.
   b. Open high-tension coil wire.
   c. Large rotor gap.
   d. Defective distributor cap.
   e. Retarded ignition timing.
   f. Overall lean fuel mixture.
   g. Auxiliary gap spark plugs.
2. If all voltages are uniform but low, check for:
   a. Closely gapped spark plugs.
   b. Advanced ignition timing.
   c. Overall low compression.
   d. Rich fuel mixture.
3. If one or more voltges are high, check for:
   a. Worn or widely gapped spark plug.
   b. Open spark plug cable.
   c. Cocked or worn distributor cap.
   d. Unbalanced fuel mixture (2 or 4 barrel carburetor only).
4. If one or more voltages are low, check for:
   a. Fouled or closely gapped spark plug.
   b. Shorted spark plug cable or cracked insulator.
   c. Low compression cylinder.
   d. Unbalanced fuel mixture (2 or 4 barrel carburetor only).

SECTION II. GM HEI AND FORD TFI SYSTEMS

9-5. DESCRIPTION. The spark voltage of all cylinders should be fairly uniform and rise slightly when the engine is snap accelerated. This test measures and compares the voltage requirements of each cylinder in an engine under load to determine if any faults are present.

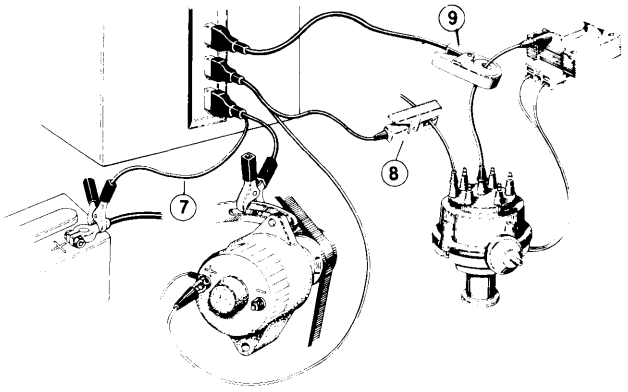
CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

9-6. HOOK-UP PROCEDURE. Refer to Figure 9-4 A or B. The scope controls and cables are numbered in Figure 9-4 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

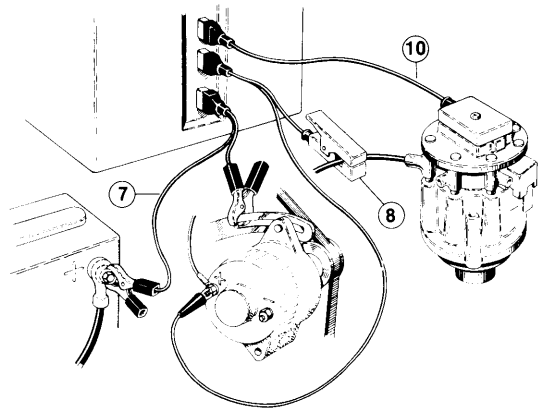
A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figures 9-4A and B.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



EXTERNAL COIL GM HEI AND FORD TFI
FIGURE 9-4A.
SPARK VOLTAGE UNDER LOAD TEST Hook-Up - GM HEI



INTEGRAL COIL GM HEI
FIGURE 9-4B.
SPARK VOLTAGE UNDER LOAD TEST Hook-Up - GM HEI

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

NOTE
In most HEI systems, the coil is mounted internally and requires the use of the HEI PATTERN CAPACITIVE PICK-UP (10) for this test. The following paragraphs provide hook-up instructions for both externally and internally mounted coils. Be sure to use the correct pick-up for the system being tested.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. **CAPACITIVE PICK-UP (9).** Use the CAPACITIVE PICK-UP (9) for HEI and TFI systems with the ignition coil mounted externally.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.
2. **HEI PATTERN CAPACITIVE PICK-UP (10).** Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap).
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 25 KV SPARK POSITION.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

9-7. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 25 KV SPARK VOLTAGE POSITION.

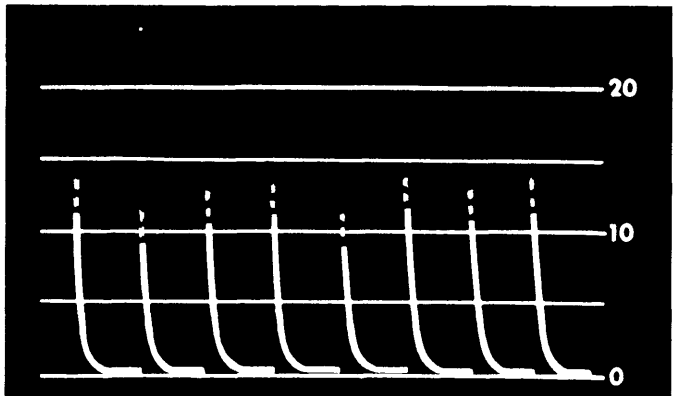
B. **Accelerate Engine.** Snap accelerate the engine by quickly depressing the accelerator pedal and then releasing it. Allow the engine to return to idle between accelerations. Do not hold the accelerator pedal down. A snap acceleration is a very rapid push-release of the accelerator pedal.

C. **Check Pattern.** During snap acceleration, compare the voltage pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 9-5 and 9-6.

D. **Engine Off.** Turn vehicle engine off.

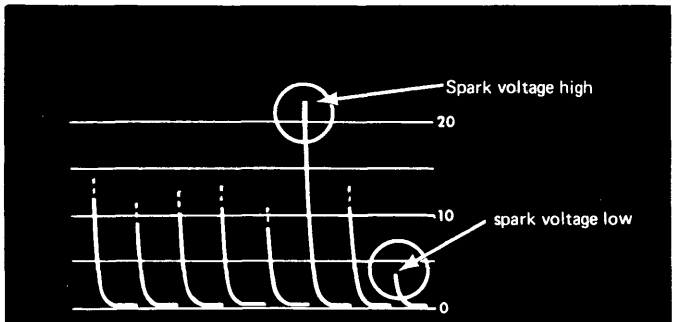
9-8. TEST RESULTS.

A. **Normal Pattern.** All spark voltages should be fairly uniform and increase slightly (1-2 KV) during snap acceleration. Engines designed to operate with a large rotor gap will display less pronounced variations in the patterns.



SPARK VOLTAGE UNDER LOAD TEST
Normal Pattern - HEI and TFI
FIGURE 9-5.

B. **Unsatisfactory Pattern.** A fault exists if the spark voltages are not uniform or if the voltage increase is either too small or too great.



SPARK PLUG VOLTAGE TEST
Unsatisfactory Pattern - HEI and TFI
FIGURE 9-6.

1. If all voltages are uniform but high, check for:
   a. Worn or widely gapped spark plugs.
   b. Open high-tension coil wire (externally mounted coil only).
   c. Large rotor gap.
   d. Defective distributor cap.
   e. Retarded ignition timing.
   f. Overall lean fuel mixture.
   g. Auxiliary gap spark plugs.
2. If all voltages are uniform but low, check for:
   a. Closely gapped spark plugs.
   b. Advanced ignition timing.
   c. Overall low compression.
   d. Rich fuel mixture.
3. If one or more voltages are high, check for:
   a. Worn or widely gapped spark plug.
   b. Open spark plug cable.
   c. Cocked or worn distributor cap.
   d. Unbalanced fuel mixture (2 or 4 barrel carburetor only).
4. If one or more voltages are low, check for:
   a. Fouled or closely gapped spark plug.
   b. Shorted spark plug cable or cracked insulator.
   c. Low compression cylinder.
   d. Unbalanced fuel mixture (2 or 4 barrel carburetor only).

CHAPTER 10.
DWELL AND VARIATION IN DWELL
TEST - BPI, GM HEI

10-1. DESCRIPTION FOR BPI. (For GM HEI see 10-5). Dwell is the period of time that the distributor points are closed during each cylinder ignition firing cycle. This test measures the variation of dwell among all the cylinders to determine specific faults in the distributor. Refer to Chapter 10.

CAUTION

Do not let test cables rest or fall on or near hot or moving engine parts.

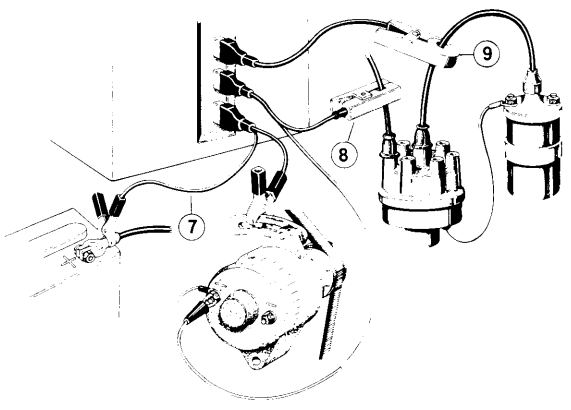
10-2. HOOK-UP PROCEDURE. Refer to Figure 10-1. The scope controls and cables are numbered in Figure 10-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 10-1.

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



DWELL AND VARIATION IN DWELL TEST Hook-Up - BPI

FIGURE 10-1.

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 25 KV superimposed.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Slide the capacitive pick-up (9) along the coil tower wire between the coil tower and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**
1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

10-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 25 KV SUPERIMPOSED position.

NOTE

Many Chrysler and Ford Breaker-Point Systems use an offset breaker plate in the distributor. Under normal operating conditions dwell variation of about 6° is typical. This variation is due to the action of the vacuum advance diaphragm on the distributor. For this test disconnect and plug any vacuum lines going to this diaphragm. With hoses disconnected, the dwell variation should be as indicated below. Be sure to reconnect the hoses after the test is finished.

B. **Adjust Pattern.** With the VERTICAL POSITION CONTROL (4), the PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6), adjust the superimposed ignition pattern to be the same width as the POINT DWELL IN DEGREES scale. Align the right edge of the pattern with the SET LINE on the right side of the screen, and the left edge of the pattern with the left edge of the screen.

C. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 10-2 and 10-3. Read the variation in dwell on the appropriate (4, 6, or 8-cylinder) scale of POINT DWELL IN DEGREES.

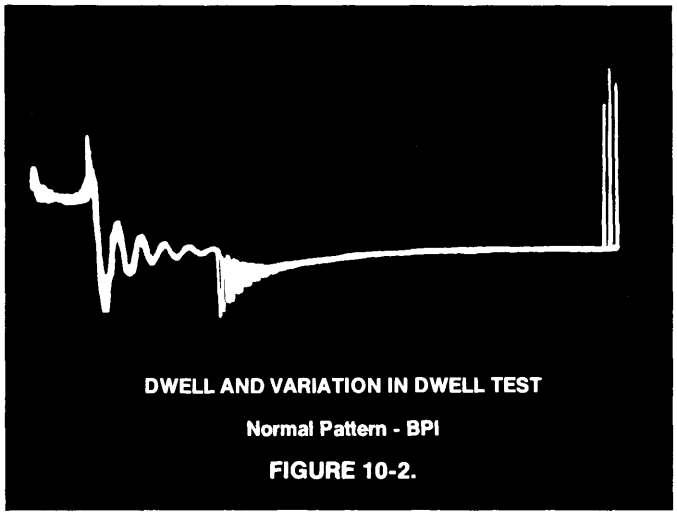
D. Repeat steps B and C at 1500 RPM.

E. **Return the engine to idle.**

F. **Engine Off.** Turn vehicle engine off.

10-4. TEST RESULTS.

A. **Normal Pattern.** The variation in dwell among all the cylinders as seen on the superimposed pattern display should be no greater than three degrees on the appropriate (4, 6, or 8-cylinder) scale.

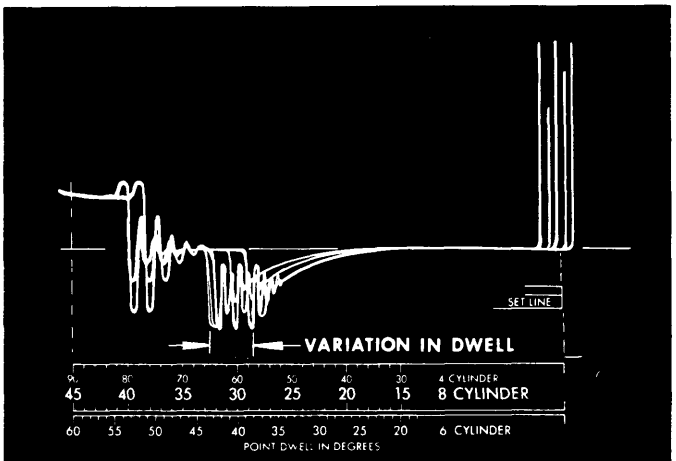


DWELL AND VARIATION IN DWELL TEST

Normal Pattern - BPI

FIGURE 10-2.

B. **Unsatisfactory Pattern.** If the variation in dwell among all the cylinders is greater than three degrees, a fault in the distributor may exist.


SET LINE
VARIATION IN DWELL
45 40 35 30 25 20 15 4 CYLINDER 8 CYLINDER
60 55 50 45 40 35 30 25 20 6 CYLINDER
POINT DWELL IN DEGREES

DWELL AND VARIATION IN DWELL TEST

Unsatisfactory Pattern - BPI

FIGURE 10-3.

If variation in dwell is greater than three degrees on the appropriate cylinder scale, then check for:

a. Worn lobes in the distributor cam.

b. Bent distributor shaft.

c. Worn distributor shaft bushings.

10-5. GM HEI

No specific readings are given by GM for their HEI system, however, it is normal for dwell to vary with engine speed on this system.

A. **HOOK-UP PROCEDURE.**

Use the same hook-up and scope control adjustment procedures described previously in this section. Be sure to use the proper capacitive pick-up, 9 or 10, as required by your particular system (integral or external coil). See Figure 9-4A or B.

B. **TEST PROCEDURE**

1. Start and warm-up the vehicle engine.
2. While observing the scope pattern, slowly accelerate from curb idle to about 2500 RPM, and de-celerate smoothly back to curb idle.

C. **RESULTS**

Dwell should increase smoothly as engine speed increases, and decrease smoothly as engine speed decreases. Any sign of jumping or erratic indication during this test may indicate a defective electronic module. Check for corroded or loose connections throughout the ignition system however, before replacing the module.

CHAPTER 11.
COIL/CONDENSER TEST
BREAKER POINT IGNITION SYSTEM

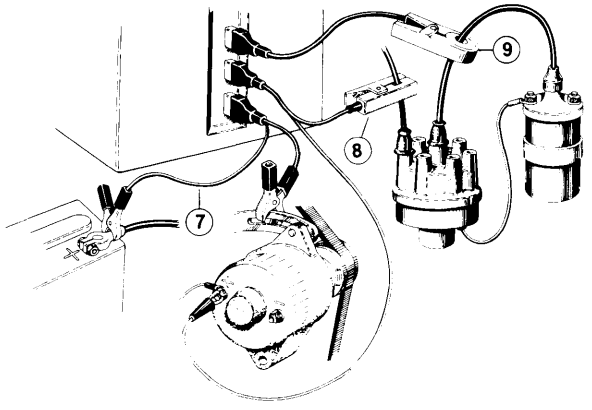
11-1. DESCRIPTION. Energy remaining in the coil after the spark plug has fired must be dissipated properly to protect the points. This test measures the dissipation of the voltage and determines if there is a fault in the coil or the condenser.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

11-2. HOOK-UP PROCEDURE. Refer to Figure 11-1. The scope controls and cables are numbered in Figure 11-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 11-1.



COIL/CONDENSER TEST Hook-Up - BPI

FIGURE 11-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.** Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).

11-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

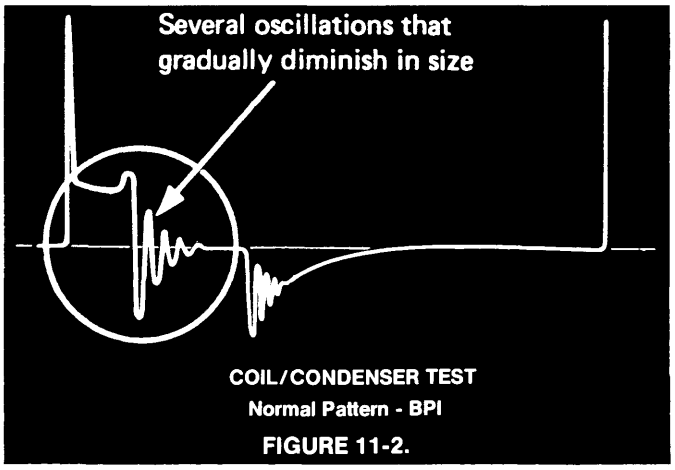
B. **Adjust Pattern.** With the PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6), adjust the ignition pattern of one cylinder so that it completely fills the screen.

C. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 11-2, 11-3 and 11-4. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 11-2.

D. **Engine Off.** Turn vehicle engine off.

11-4. TEST RESULTS.

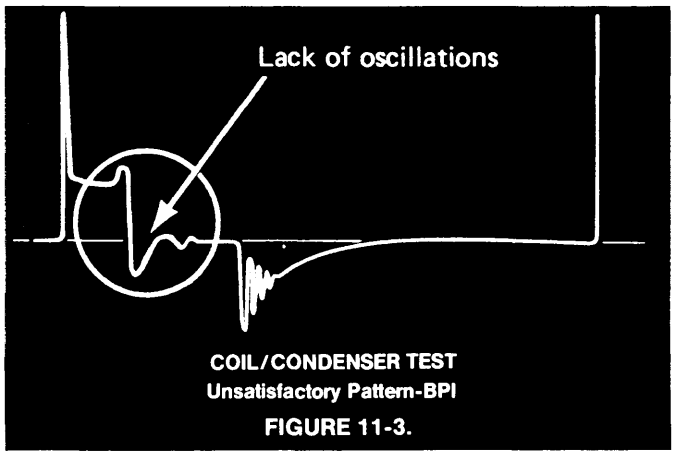
A. **Normal Pattern.** The proper dissipation of energy in both the coil/condenser section and the dwell section of the ignition scope pattern appears as several diminishing oscillations.



COIL/CONDENSER TEST
Normal Pattern - BPI
FIGURE 11-2.

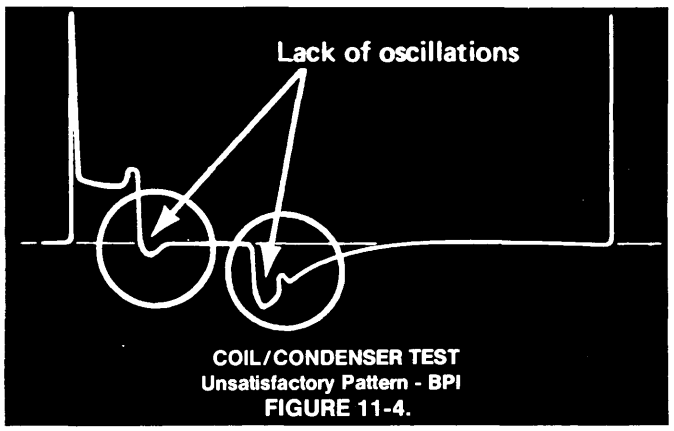
B. **Unsatisfactory Pattern.** An unsatisfactory pattern lacks oscillations in either or both the coil/condenser section and the dwell section of the ignition scope pattern.

1. If the pattern lacks oscillations in the coil/condenser section only, check for a leaky condenser.



COIL/CONDENSER TEST
Unsatisfactory Pattern-BPI
FIGURE 11-3.

2. If the pattern lacks oscillations throughout, check for a defective coil. (This pattern may occur when the scope is used in conjunction with some automobile analyzers. Disconnect the Analyzer to see if the pattern returns to normal before replacing the coil.)



COIL/CONDENSER TEST
Unsatisfactory Pattern - BPI
FIGURE 11-4.

CHAPTER 12.
POINT ACTION TEST - BPI

12-1. DESCRIPTION It is important that the points open and close properly for each spark plug firing. This test checks for proper action of the breaker points.

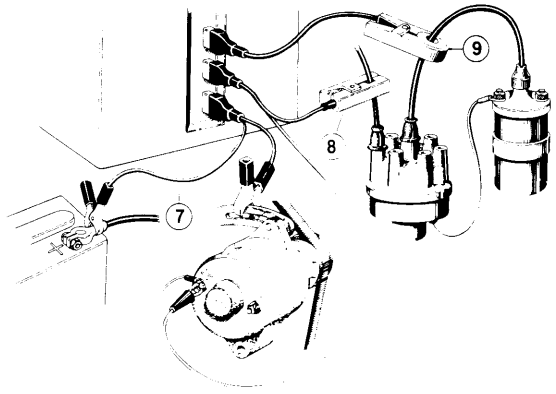
CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

12-2. HOOK-UP PROCEDURE. Refer to Figure 12-1. The scope controls and cables are numbered in Figure 12-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the alternator bracket as shown in Figure 12-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



POINT ACTION TEST Hook-Up - BPI

FIGURE 12-1.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN position.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**
1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the first spark plug firing cycle pattern fills the entire screen.

12-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

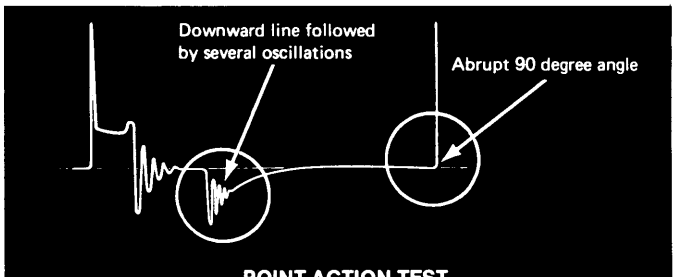
B. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 12-2 and 12-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 12-2.

C. Using the PATTERN POSITION CONTROL, parade the spark plug firing cycles through from left to right, one at a time—pausing and observing each spark plug's pattern as described in step 12-3.B.

D. **Engine Off.** Turn vehicle engine off.

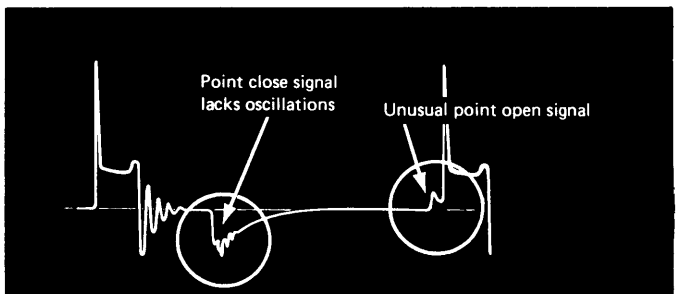
12-4. **TEST RESULTS.**

A. **Normal Pattern.** Proper point action is most obvious in the dwell section of the ignition scope pattern. The point close signal is composed of a downward line followed by several diminishing oscillations. The point open signal is represented by an abrupt 90 degree angle upward.



POINT ACTION TEST
Normal Pattern - BPI
FIGURE 12-2.

B. **Unsatisfactory Pattern.** When the point close signal lacks oscillations or the point open signal appears unusual, the pattern is unsatisfactory and represents faults in the breaker point action.



POINT ACTION TEST
Unsatisfactory Pattern - BPI
FIGURE 12-3.

1. If an unsatisfactory pattern exists at the point close signal, check for:
   a. Dirty Points.
   b. Burned points.
   c. Point misalignment.
   d. Point bounce.
   e. Weak point spring tension.

NOTE: New points may produce a pattern with few or intermittent oscillations at point close. This is not abnormal and should correct itself after the points have become properly seated.

2. If an unsatisfactory pattern exists at the point open signal, check for:
   a. Dirty Points.
   b. Burned points.
   c. Pitted points
   d. Faulty condenser.

CHAPTER 13.
SECONDARY RESISTANCE TEST
ALL IGNITION SYSTEMS

13-1. DESCRIPTION. A limited amount of resistance is built into the secondary circuit to extend the spark plug electrode life and to minimize interference with radio and television reception. Excessive resistance dissipates the energy needed to maintain good ignition during high speed operation. This test checks for excessive secondary resistance.

CAUTION

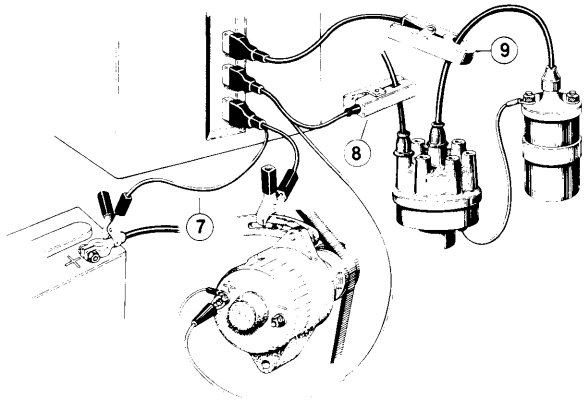
Do not let test cables rest or fall on or near hot or moving engine parts.

31-2. HOOK-UP PROCEDURE. Refer to Figure 13-1 A, B, or C. The scope controls and cables are numbered in Figure 13-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

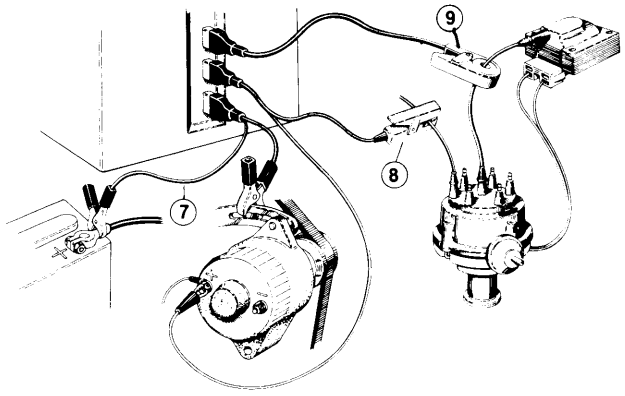
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 13-1 A, B or C.



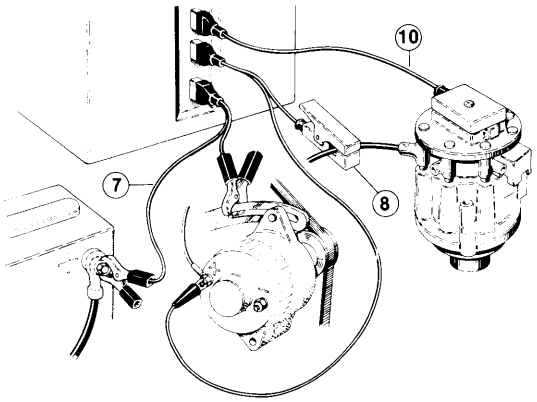
CYLINDRICAL COIL SYSTEMS
FIGURE 13-1A.
SECONDARY RESISTANCE TEST Hook-Up

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.



"E" CORE COIL SYSTEMS
(GM HEI, FORD TFI, TFI-I and IV)
FIGURE 13-1B.



INTEGRAL COIL GM HEI
FIGURE 13-1C.
SECONDARY RESISTANCE TEST Hook-Up

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. **CAPACITIVE PICK-UP (9).** Use the CAPACITIVE PICK-UP (9) for HEI and TFI systems with the ignition coil mounted externally. Refer to Figure 13-1 B.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.
2. **HEI PATTERN CAPACITIVE PICK-UP (10).** Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap). Refer to Figure 13-1C.
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.** Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN position.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

13-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

B. **Adjust Pattern.** With the PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6), adjust the ignition pattern of the number one cylinder so that it completely fills the screen.

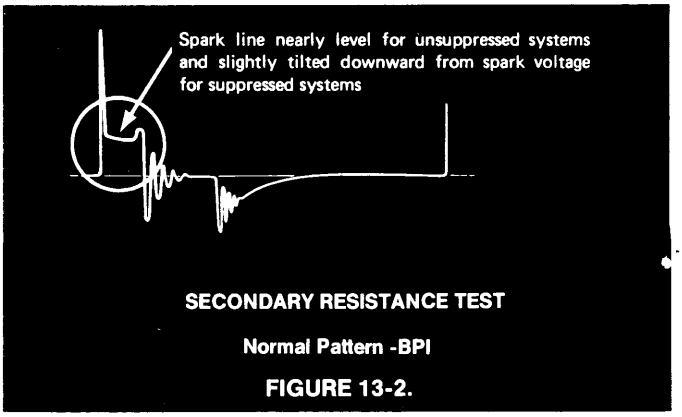
C. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, figures 13-2 and 13-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 13-2. (The pattern illustrated is for BPI. Oscillation detail on electronic ignition systems will vary as shown in chapter 5.)

D. **Parade Pattern.** Turn the PATTERN POSITION CONTROL (5) counterclockwise and compare the patterns of each cylinder with the patterns illustrated below in Test Results.

E. **Engine Off.** Turn vehicle engine off.

13-4. TEST RESULTS.

A. **Normal Pattern.** Resistance in the secondary circuit is normal when the spark line is tilted downward slightly from the spark voltage line in suppressed ignition systems or nearly level in unsuppressed ignition systems.

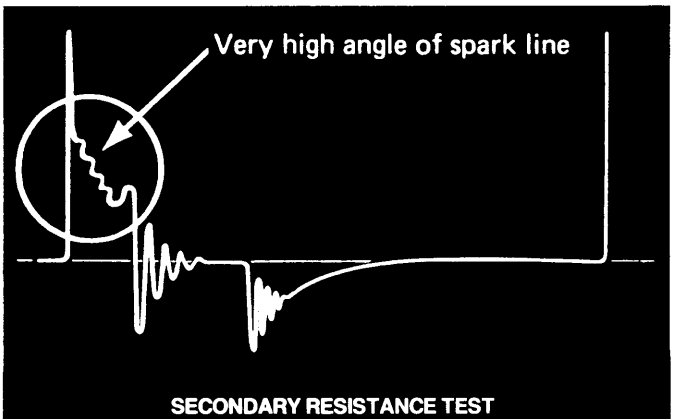

Spark line nearly level for unsuppressed systems and slightly tilted downward from spark voltage for suppressed systems

SECONDARY RESISTANCE TEST

Normal Pattern -BPI

FIGURE 13-2.

B. **Unsatisfactory Pattern.** Excessive resistance appears as a steeply angled spark line.



SECONDARY RESISTANCE TEST

Unsatisfactory Pattern - BPI.

FIGURE 13-3.

1. If an unsatisfactory pattern exists for all cylinders, check for:
   a. Corroded coil wire terminals.
   b. Open coil wire or radio suppressor.
   c. Burned carbon button in the distributor cap.
   d. Burned distributor cap segments.
   e. Burned rotor tip.
2. If one or more, but not all, cylinders test unsatisfactorily, check for:
   a. High resistance or open spark plug wires.
   b. Corroded distributor cap towers.
   c. Burned distributor cap segements.
   d. Defective spark plugs.
      1.) Cracked porcelain insulator
      2.) Open internal Resistor (Resistor type plugs only)

CHAPTER 14.
COIL OUTPUT AT CRANKING SPEED TEST
BREAKER POINT IGNITION SYSTEM

14-1. DESCRIPTION. A fault in the primary circuit or a defective coil may cause an engine to be hard to start or fail to start. This test determines if these systems are the cause of a starting problem.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

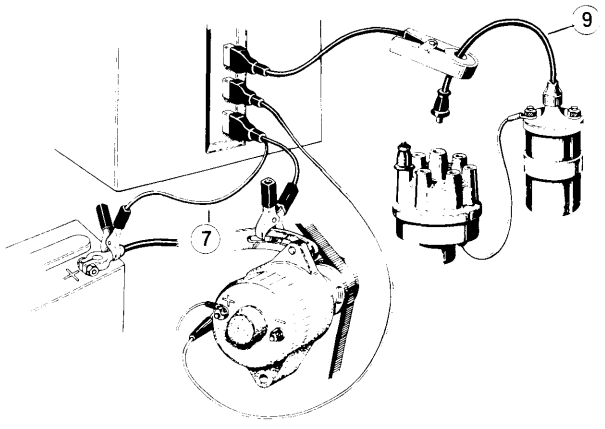
CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

14-2. HOOK-UP PROCEDURE. Refer to Figure 14-1. The scope controls and cables are numbered in Figure 14-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 14-1.



COIL OUTPUT AT CRANKING SPEED Hook-Up

FIGURE 14-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Do not connect for COIL OUTPUT AT CRANKING SPEED TEST.
2. **Vehicle.** Do not connect for COIL OUTPUT AT CRANKING SPEED TEST.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 50 KV COIL.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start engine.** Start the engine and allow it to warm to normal operating temperature.

NOTE
If vehicle is equipped with a non-resistor coil wire, replace the high tension coil wire with resistance wire just for this test.

I. **Adjust Position Controls.**
1. Set the trace to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. With the PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6), adjust the trace so that it fills the screen.

14-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 50 KV COIL position.

B. **Disconnect High Tension Coil Wire.** Remove the high tension coil wire from the distributor cap. Keep the exposed end of high tension wire from grounding.

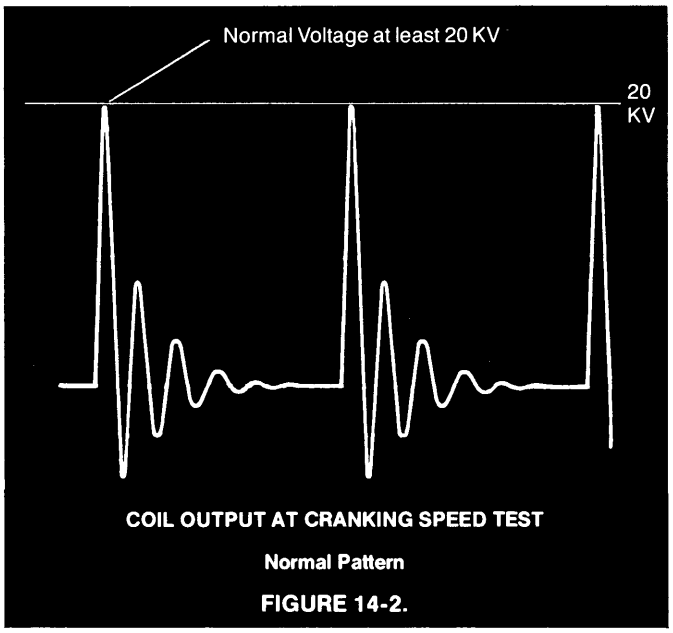
C. **Crank Engine.** With ignition switch on, crank vehicle engine and observe the pattern.

D. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 14-2 and 14-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 14-2. Observe the coil output voltage on the 50 KV scale.

E. **Reconnect.** Reconnect the high tension coil wire.

14-4. TEST RESULTS.

A. **Normal Pattern.** When the primary circuit and the ignition coil are functioning properly, the coil output voltage will extend at least 20 KV above the zero line.

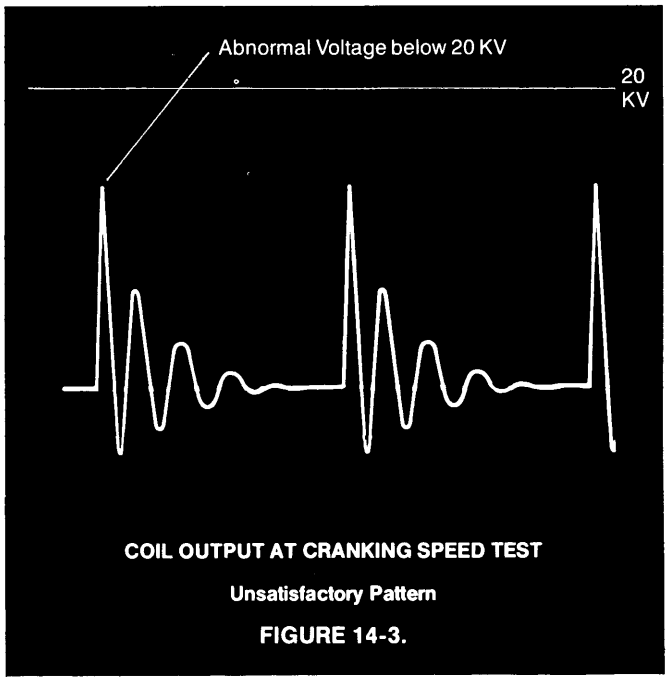


COIL OUTPUT AT CRANKING SPEED TEST

Normal Pattern

FIGURE 14-2.

B. **Unsatisfctory Pattern.** When the coil output voltage is less than 20 KV above the zero line, the pattern is unsatisfactory.



COIL OUTPUT AT CRANKING SPEED TEST

Unsatisfactory Pattern

FIGURE 14-3.

1. If the voltage reading is under 20 KV, check for:
   a. Low battery.
   b. Failure of ballast resistor bypass circuit.
   c. Defective coil. (Shorted turns, carbon tracking, cracked)
   d. Defective condenser.
   e. Defective coil wire.
   f. Excessive distributor resistance.
   g. Inoperative contact points.

Use your engine analyzer and vehicle service manual to trouble shoot these areas.

CHAPTER 15.
ROTOR GAP TEST
SECTION I. BPI, ALL CHRYSLER ELECTRONIC, FORD, SSI, DS SYSTEMS, PRESTOLITE BID SYSTEMS

15-1. DESCRIPTION. Adequate voltage is required to properly arc the gap between the rotor and the distributor cap terminals. This test measures the voltage of the arc to determine possible faults in this circuit.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

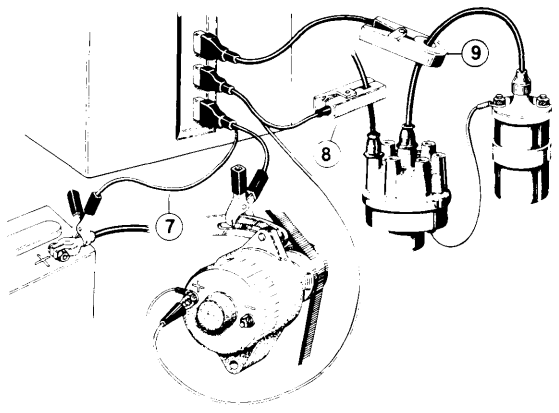
CAUTION
Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

15-2. HOOK-UP PROCEDURE. Refer to Figure 15-1. The scope controls and cables are numbered in Figure 15-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the alternator bracket as shown in Figure 15-1.



ROTOR GAP TEST Hook-Up

FIGURE 15-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE
Ensure the the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

C. **CAPACITIVE PICK-UP (9) Connections.**
1. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
2. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.

D. **INDUCTIVE PICK-UP (8) Connections.**
1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 25 KV SPARK position.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:
1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

15-3. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 25 KV SPARK position.

CAUTION

Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.

DO NOT DISCONNECT:

V-8 engines:	No. 1 or No. 8 spark plug wire.
V-6 engines:	No. 1 or No. 4 spark plug wire.
I-6 engines:	No. 3 or No. 5 spark plug wire.
4-Cylinder engines:	No. 1 or No. 3 spark plug wire.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 15-2.D.

D. **Ground Distributor Terminal.** Insert a metal prod into the open distributor terminal and ground it by connecting a jumper wire from the metal prod to the engine block.

E. **Engine On.** Start vehicle engine. Operate at 900-1200 RPM.

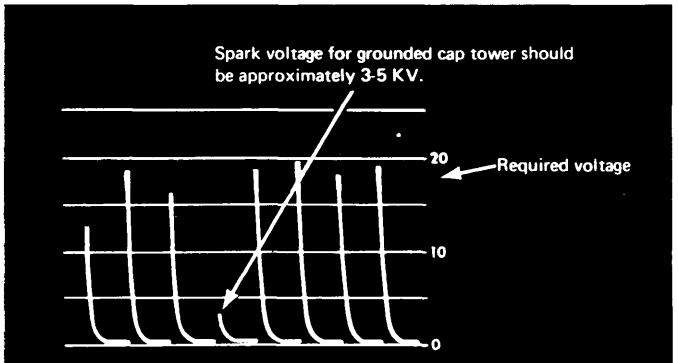
F. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 15-2 and 15-3. Read the pattern on the 25 KV scale.

G. **Engine Off.** Turn vehicle engine off.

H. **Reconnect.** Reconnect spark plug wire.

15-4 TEST RESULTS.

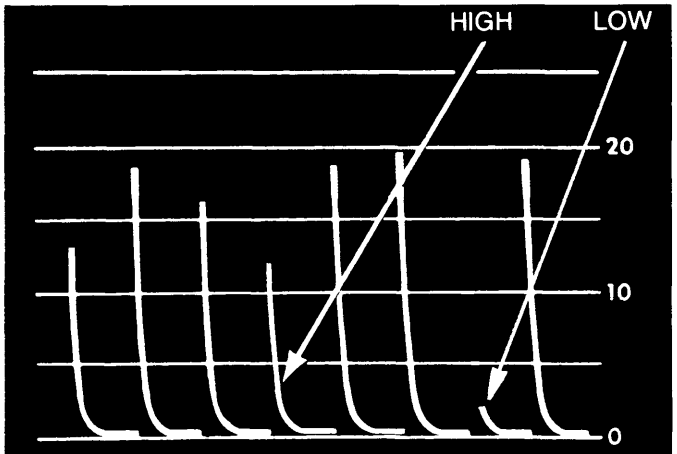
A. **Normal Pattern.** The spark voltage of the grounded distributor terminal should be approximately 3-5 KV, (BPI only). Many of the newer electronic ignitions operate with a significantly higher rotor gap, (approximately, 8 KV).



ROTOR GAP TEST Normal Pattern - BPI

FIGURE 15-2.

B. **Unsatisfactory Pattern.** If the spark voltage of the grounded distributor terminal is less than 3 KV (BPI), then the pattern is unsatisfactory.



ROTOR GAP TEST Unsatisfactory Pattern - BPI

FIGURE 15-3.

1. If voltage reading remains high, check for:
   a. Wrong rotor, (tip too short).
   b. Corroded rotor tip.
   c. Defective distributor cap.
2. If voltage reading is excessively low, check for:
   a. Wrong rotor, (tip too long).
   b. Defective distributor cap.

SECTION II. GM HEI, FORD TFI SYSTEMS

15-5. DESCRIPTION. Adequate voltage is required to properly arc the gap between the rotor and the distributor cap terminals. This test measures the voltage of the arc to determine possible faults in this circuit.

CAUTION

Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION

Use caution when disconnecting and connecting spark plug and high tension wires, as they can be damaged easily.

CAUTION

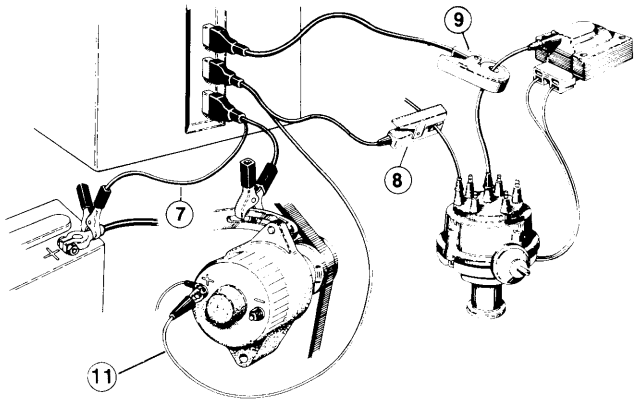
On cars equipped with a catalytic converter, reconnect spark plug wire as quickly as possible to avoid damage to converter. Do not allow car to run with a plug not firing; overheating will result.

15-6. HOOK-UP PROCEDURE. Refer to Figures 15-4A and B. The scope controls and cables are numbered in Figures 15-4A and B as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

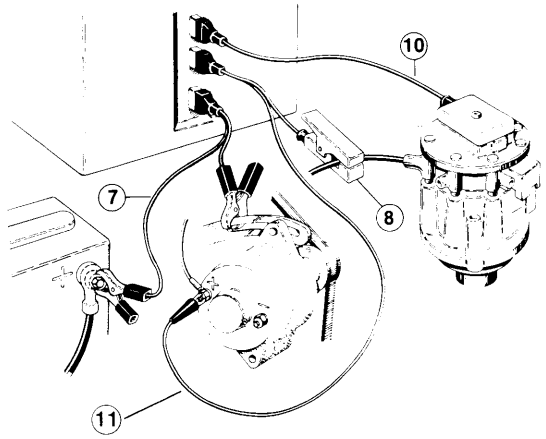
A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as show in Figure 15-4 A or B.



"E" CORE COIL SYSTEMS (GM HEI, FORD TFI, TFI-I and IV) FIGURE 15-4A.



INTEGRAL COIL GM HEI FIGURE 15-4B.

ROTOR GAP TEST Hook-Up - HEI

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE: Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.

NOTE: In some HEI systems, the coil is mounted internally and requires the use of the HEI PATTERN CAPACITIVE PICK-UP (10) for this test. The following paragraphs provide hook-up instructions for both externally and internally mounted coils. Be sure to use the correct pick-up for the system being tested.

C. **CAPACITIVE PICK-UP (9) or GM HEI PATTERN CAPACITIVE PICK-UP (10) Connections.**

1. **CAPACITIVE PICK-UP (9).** Use the CAPACITIVE PICK-UP (9) for HEI, and TFI systems with the ignition coil mounted externally.
   a. **Scope.** Plug the yellow CAPACITIVE PICK-UP (9) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clamp the CAPACITIVE PICK-UP (9) onto the high-tension coil wire.
2. **HEI PATTERN CAPACITIVE PICK-UP (10).** Use the HEI PATTERN CAPACITIVE PICK-UP (10) for HEI systems with the ignition coil mounted internally (inside the distributor cap).
   a. **Scope.** Plug the yellow HEI PATTERN CAPACITIVE PICK-UP (10) connector into the yellow socket on the back of the scope.
   b. **Vehicle.** Clip the HEI PATTERN CAPACITIVE PICK-UP (10) onto the top of the distributor cap.

D. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   Clamp the INDUCTIVE PICK-UP (8) onto the spark plug wire of the No. 1 spark plug. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to 25 KV SPARK position.

F. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

H. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

I. **Adjust Engine Speed.** Adjust engine speed as required to provide a stable pattern (typically 900–1200 RPM).

J. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamps are clean and completely enclose ignition wires.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

K. **Adjust Position Controls.**

1. Set the pattern to zero line on the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

15-7. TEST PROCEDURE.

A. **Engine Off.** Turn vehicle engine off.

B. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the 25 KV SPARK POSITION.

CAUTION

On HEI systems do not disconnect spark plug wires at the distributor during testing.

CAUTION

Selection of spark plug wires to be disconnected is critical on Ford Electronic Ignition Systems. Unless properly selected, damage to the ignition system electronics may result.

DO NOT DISCONNECT:

V-8 engines:	No. 1 or No. 8 spark plug wire.
V-6 engines:	No. 1 or No. 4 spark plug wire.
I-6 engines:	No. 3 or No. 5 spark plug wire.
4-Cylinder engines:	No. 1 or No. 3 spark plug wire.

C. **Spark Plug Wire Disconnect.** With the fiber pliers provided, disconnect any properly selected spark plug wire with boot at the spark plug end, except the wire leading to the No. 1 spark plug. Do not allow this wire to arc to ground. The INDUCTIVE PICK-UP should be clamped to the No. 1 spark plug wire as instructed above in paragraph 15-6.D.

D. **Ground Spark Plug Wire.** Ground the disconnected spark plug wire to the engine block with a jumper wire.

E. **Engine On.** Start vehicle engine. Operate at 900–1200 RPM.

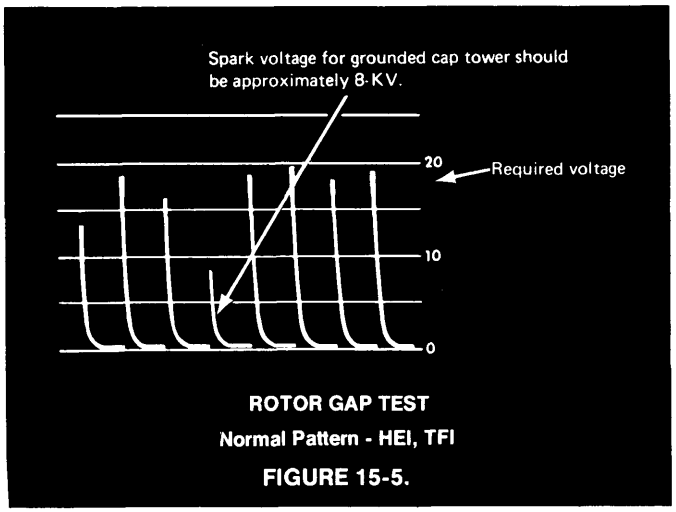
F. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 15-5 and 15-6. Read the pattern on the 25 KV scale.

G. **Engine Off.** Turn vehicle engine off.

H. **Reconnect.** Reconnect spark plug wire.

15-8. TEST RESULTS.

A. **Normal Pattern.** The spark voltage of the grounded distributor terminal should be approximately 8 KV.

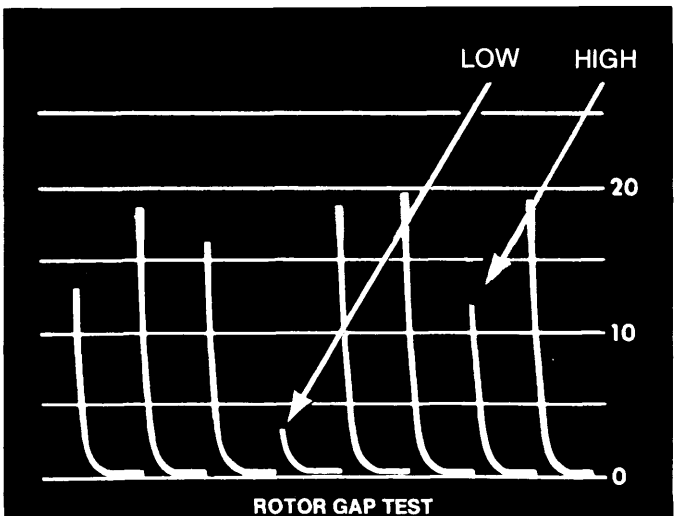


ROTOR GAP TEST

Normal Pattern - HEI, TFI

FIGURE 15-5.

B. **Unsatisfactory Pattern.** If the spark voltage of the grounded distributor terminal is significantly lower or higher than 8 KV, then the pattern is unsatisfactory.



ROTOR GAP TEST

Unsatisfactory Pattern - HEI, TFI

FIGURE 15-6.

1. If voltage reading remains high, check for:
   a. Wrong rotor, (tip too short).
   b. Corroded rotor tip.
   c. Defective distributor cap.
2. If voltage reading remains low, check for:
   a. Wrong rotor, (tip too long).
   b. Defective distributor cap.

CHAPTER 16.
ALTERNATOR TEST
All Ignition Systems

16-1. DESCRIPTION. Faults in alternator operation can be determined by analysis of the scope patterns produced in this test.

WARNING

The gases generated by a charging battery are highly explosive. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is charging. Any room or compartment containing charging batteries should be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while battery is charging, and always turn charger off before disconnecting the battery clips. When removing or reconnecting battery cables, make sure ignition switch and all accessories are turned off. It is advisable to blow across the top of the battery before making or breaking connections to it. This will disperse any explosive gases which may have accumulated on it.

CAUTION

Do not let test cables rest or fall on or near hot or moving engine parts.

16-2. HOOK-UP PROCEDURE. Refer to Figure 16-1. The scope controls and cables are numbered in Figure 16-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

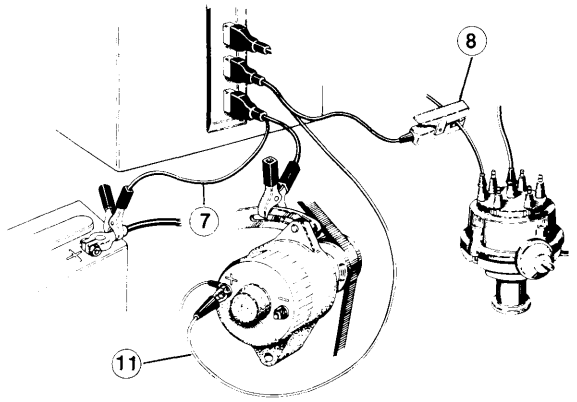
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (−) ground on the vehicle such as the alternator bracket as shown in Figure 16-1.

WARNING

When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

NOTE

Ensure that the CAPACITIVE and INDUCTIVE PICK-UP clamps completely enclose ignition wires and are free of dirt and grease. Dirty or incompletely closed clamps may cause mistriggering and/or faulty calibration of scope patterns.



ALTERNATOR TEST - Hook-Up

FIGURE 16-1.

C. **INDUCTIVE PICK-UP (8) Connections.**

1. **Scope.** Plug the blue INDUCTIVE PICK-UP (8) connector into the blue socket on the back of the scope.
2. **Vehicle.**
   a. Clamp the INDUCTIVE PICK-UP (8) onto the No. 1 spark plug wire. Connect the pick-up as close as possible to the distributor to minimize interference from adjacent wires.

WARNING

The positive (+) stud of the alternator is live; use care when making this connection so that you do not create a spark which could cause an explosion.

   b. Clip the blue alligator clip of the ALTERNATOR LEAD (11) (part of INDUCTIVE PICK-UP) to the positive (+) output stud of the alternator. If it is inconvenient or dangerous to access the alternator stud, connect the alligator clip to the positive (+) terminal of the battery. Connecting the alternator LEAD to the battery may result in a pattern smaller in amplitude than when connected to the alternator, but of the same shape.

D. **Select Function.** Rotate FUNCTION SELECTOR (3) to the ALT position.

E. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

F. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE

A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

G. **Start Engine.** Start the engine and allow it to warm to normal operating temperature.

H. **Adjust Engine Idle Speed.** Adjust engine speed as required to provide a stable pattern (typically 900-1200 RPM).

I. **Adjust Scope Pattern.** If the scope pattern blinks or is unstable:

1. Ensure that pick-up clamp is clean and completely encloses the No. 1 spark plug wire.
2. Turn the INDUCTIVE PICK-UP (8) clamp over and slide it along the spark plug wire between the spark plug and the distributor until pattern stabilizes.
3. If vehicle is equipped with non-resistor spark plug wires, replace the ignition coil wire and the No. 1 spark plug wire with resistance wire just for this test.

J. **Adjust Position Controls.**

1. Set the pattern to the center of the scope screen with the VERTICAL POSITION CONTROL (4).
2. Adjust PATTERN POSITION CONTROL (5) and PATTERN LENGTH CONTROL (6) so that the pattern fills the entire screen.

16-3. TEST PROCEDURE.

A. **Load Charging System.** Turn on the test vehicle headlights, and HI fan, to load the charging system. This will also increase the height of the pattern.

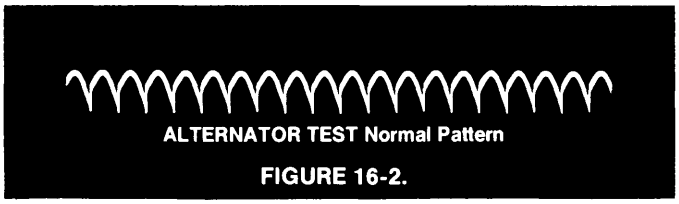
B. **Adjust Pattern.** Turn the PATTERN POSITION CONTROL (5) to obtain an easily viewable pattern. Adjust the PATTERN LENGTH CONTROL (6) so that the pattern completely fills the screen. Turn the VERTICAL POSITION CONTROL (4) to move the pattern to a viewable position.

C. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 16-2 through 16-9. Although the basic alternator pattern may vary in vertical size and shape depending on the engine speed and alternator output, the pattern displayed on the scope screen should appear similar to the normal pattern illustrated in Figure 16-2.

D. **Accessories off.** Turn headlights and fan off.

E. **Engine Off.** Turn vehicle engine off.

16-4. TEST RESULTS.

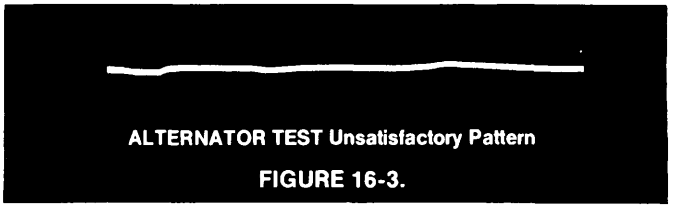


ALTERNATOR TEST Normal Pattern

FIGURE 16-2.

A. **Normal Pattern.** The normal alternator pattern will display consistent, smooth oscillations as shown in Figure 16-2. Evenly spaced ignition spikes which may appear throughout the pattern should be disregarded.

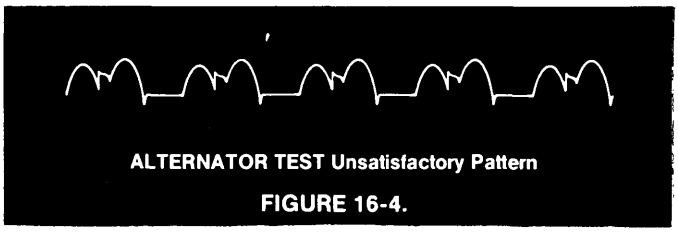
B. **Unsatisfactory Patterns.**



ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-3.

1. Open field or defective regulator. (Fig. 16-3)



ALTERNATOR TEST Unsatisfactory Pattern

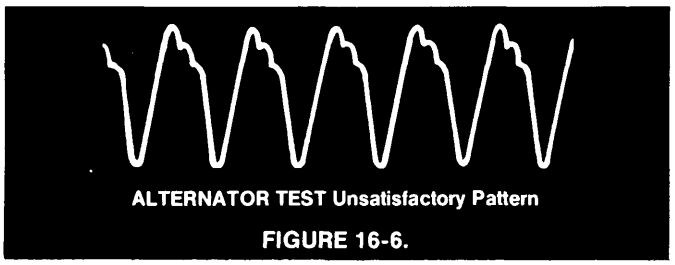
FIGURE 16-4.

2. Shorted diode. (Fig. 16-4)

ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-5.

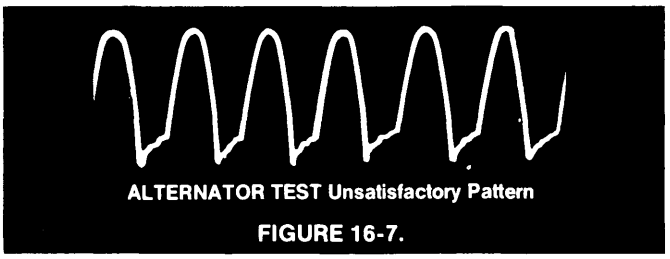
3. Open diode. (Fig. 16-5)



ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-6.

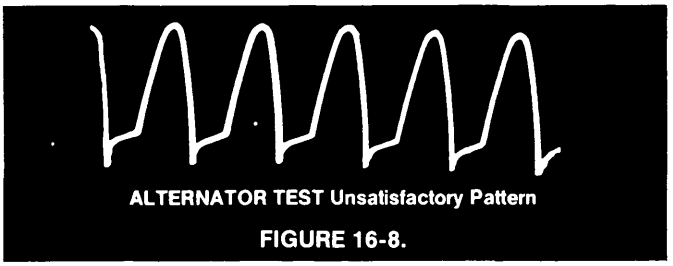
4. Shorted winding. (Fig. 16-6)



ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-7.

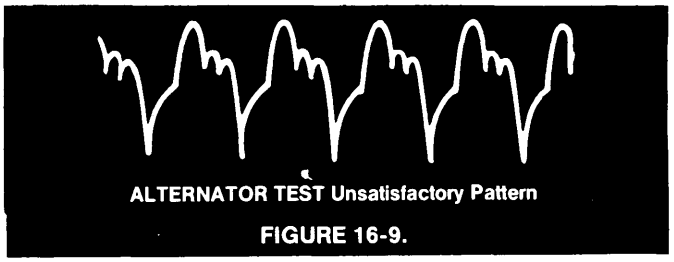
5. Open winding or two open diodes, one phase. (Fig. 16-7)



ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-8.

6. One shorted diode and one open diode, opposite polarity. (Fig. 16-8)



ALTERNATOR TEST Unsatisfactory Pattern

FIGURE 16-9.

7. One shorted diode and one open diode, same polarity. (Fig. 16-9)

Abnormal Pattern. Any pattern obtained other than that shown in Figure 16-2 should be considered abnormal. Further diagnosis on the charging system should be done in accordance with your vehicle service manual.

CHAPTER 17.
MAGNETIC PICK-UP COIL TEST
SECTION I. GM HEI System

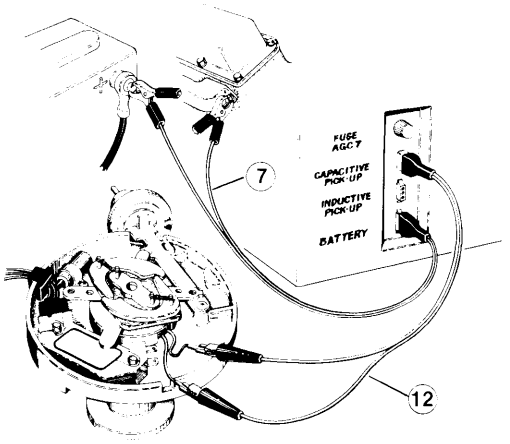
17-1. DESCRIPTION. Some electronic ignition systems use a magnetic pickup coil and reluctor assembly in place of contact points. Faults in operation of this assembly may be determined by this test. This test is indicated when no start, hard start, or vehicle "bucking when driving" condition is encountered.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

17-2. HOOK-UP PROCEDURE. Refer to Figure 17-1. The scope controls and cables are numbered in Figure 17-1 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the engine block as shown in Figure 17-1.



MAGNETIC PICK-UP COIL TEST Hook-Up - HEI

FIGURE 17-1.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

CAUTION
Do not allow PICK-UP COIL TEST LEAD clips to touch each other or the vehicle ground.

C. **PICK-UP COIL TEST LEAD (12) Connections.**
1. **Scope.** Plug the yellow PICK-UP COIL TEST LEAD (12) connector into the yellow socket on the back of the scope.
2. **Vehicle.**
   a. Remove distributor cap and rotor. (If necessary for clearance on V-6 and V-8 engines, also remove distributor BAT lead and module connector at the distributor cap.) To avoid damage to the rotor, and high tension output contact in the cap, pull the cap straight up at least one inch before tipping to remove.
   b. Disconnect the white and the green wires from the pick-up coil side of the electronic module and connect the PICK-UP COIL TEST LEAD clips to the wires as shown in Figure 17-1.

D. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN position.

E. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counter-clockwise to stop.

F. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

17-3. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

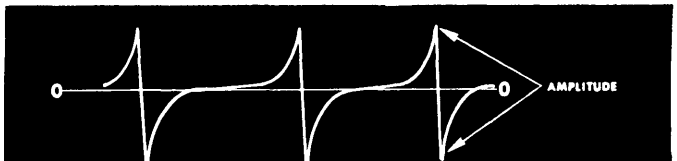
B. **Crank Engine.** Have a helper crank the engine.

C. **Check Pattern.** Compare the pattern displayed on the scope while the engine is cranking with the patterns illustrated below in Test Results, Figures 17-2 and 17-3. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 17-2. While the engine is cranking, gently wiggle or flex the green and white wires from the pick-up coil while observing the scope display. The pattern shown in Figure 17-2 should remain constant. If there is any sign of erratic operation check the pick-up coil wires for insulation nicks, cuts or wear, and check the terminals for good connections.

D. **Reconnect.** Remove test leads, reconnect all wires and replace the distributor cap.

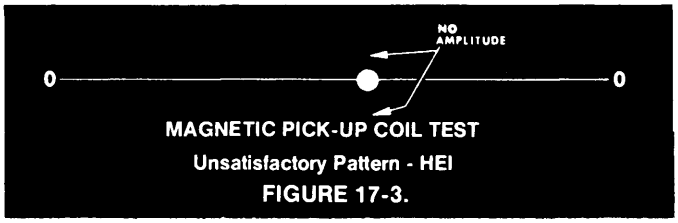
17-4. TEST RESULTS.

A. **Normal Pattern.**



MAGNETIC PICK-UP COIL TEST
Normal Pattern - HEI
FIGURE 17-2.

B. **Unsatisfactory Pattern.** A line with no vertical amplitude is an unsatisfactory pattern.



MAGNETIC PICK-UP COIL TEST
Unsatisfactory Pattern - HEI
FIGURE 17-3.

If an unsatisfactory pattern exists, the magnetic pick-up coil is not functioning properly.
Check the pick-up coil with an ohmmeter. There should be no reading (infinity) from either wire to ground and the resistance across the coil should be between 500-1500 ohms.

SECTION II. CHRYSLER Electronic Systems (6 and 8 Cylinder Only)

17-5. DESCRIPTION. Some electronic ignition systems use a magnetic pickup coil and reluctor assembly in place of contact points. Faults in operation of this assembly may be determined by this test. This test is indicated when no start, hard start, or vehicle "bucking when driving" condition is encountered.

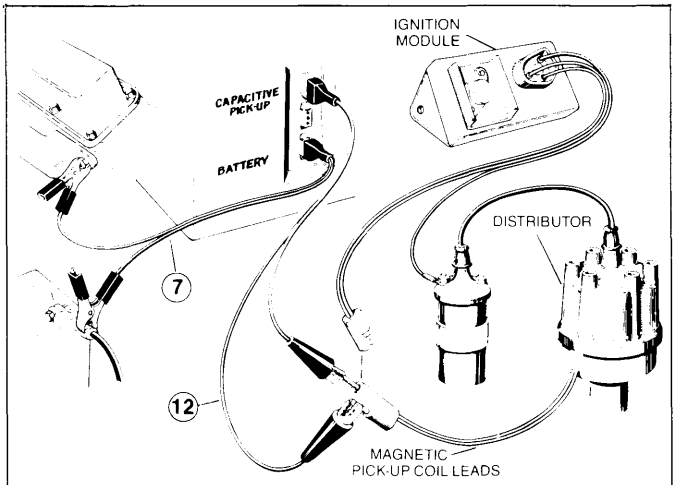
CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

CAUTION
Do not attempt to test Hall effect ignition systems using this test procedure. The Hall effect switch could be destroyed.

17-6. HOOK-UP PROCEDURE. Refer to Figure 17-4. The scope controls and cables are numbered in Figure 17-4 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:
1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the engine block as shown in Figure 17-4.



MAGNETIC PICK-UP COIL TEST Hook-Up - EIS
FIGURE 17-4.

WARNING
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

CAUTION
Do not allow PICK-UP COIL TEST LEAD clips to touch each other or the vehicle ground.

C. **PICK-UP COIL TEST LEAD (12) Connections.**
1. **Scope.** Plug the yellow PICK-UP COIL TEST LEAD (12) connector into the yellow socket on the back of the scope.
2. **Vehicle.**
   a. Disconnect the two wire connector between the distributor and the electronic module.

NOTE: Some Chrysler Electronic Ignition Systems use two pick-up coils (Start and Run). Each of these coils may be tested separately using the same procedure.

   b. Connect the PICK-UP COIL TEST LEAD clips to the distributor side of the connector as shown in Figure 17-4.

E. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN position.

F. **Pattern Controls.**
1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counterclockwise to stop.

G. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

NOTE
A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

17-7. TEST PROCEDURE.

A. **Select Function.** Ensure that FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

B. **Crank Engine.** Have a helper crank the engine.

C. **Check Pattern.** Compare the pattern displayed on the scope while the engine is cranking with the patterns illustrated below in Test Results, Figures 17-5 and 17-6. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 17-5. While the engine is cranking, gently wiggle or flex the pick-up coil wires their full length while observing the scope display. The pattern shown in Figure 17-5 should remain constant. If there is any sign of erratic operation check the pick-up coil wires for insulation nicks, cuts, or wear, and check the terminals for good connections.

D. **Reconnect.** Remove test leads; reconnect all wires and connectors.

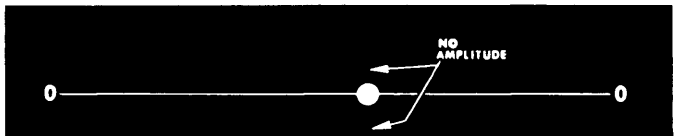
17-8. TEST RESULTS.

A. **Normal Pattern.**

MAGNETIC PICK-UP COIL TEST
Normal Pattern - Chrysler
FIGURE 17-5.

B. **Unsatisfactory Pattern.** A line with no vertical amplitude is an unsatisfactory pattern. If an unsatisfactory pattern exists, the magnetic pick-up coil is not functioning properly.

1. Check the pick-up coil with an ohmmeter. There should be no reading (infinity) from either wire to ground and the resistance across the coil should be 150–900 ohms.



MAGNETIC PICK-UP COIL TEST
Unsatisfactory Pattern - Chrysler
FIGURE 17-6.

SECTION III. FORD SSI, DSI, DSII Systems

17-9. DESCRIPTION. Some electronic ignition systems use a magnetic pickup coil and reluctor assembly in place of contact points. Faults in operation of this assembly may be determined by this test. This test is indicated when no start, hard start, or vehicle "bucking when driving" condition is encountered.

CAUTION
Do not let test cables rest or fall on or near hot or moving engine parts.

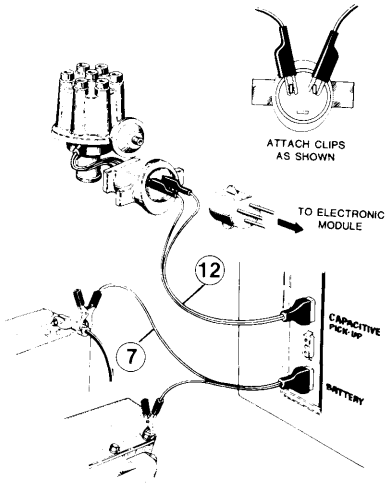
CAUTION
Do not attempt to test Hall effect ignition systems using this test procedure. The Hall effect switch could be destroyed.

17-10. HOOK-UP PROCEDURE. Refer to Figure 17-7. The scope controls and cables are numbered in Figure 17-7 as a reference for hookup. This procedure explains where to hook up each cable on the back of the scope and on the vehicle being tested. The scope connections (leads and sockets) are color coded and keyed to ensure proper hookup. The scope items are described in detail in Chapter 2, Figure 2-1, Table 2-1.

A. **Engine Off.** Do not start the engine before hookup.

B. **POWER LEAD Connections.**
Make the following connections:

1. **Scope.** Plug the black POWER LEAD (7) connector into the black socket on the back of the scope.
2. **Vehicle.** Connect the POWER LEADS (7) to the battery as follows: the RED clip to the Positive (+) battery terminal and the BLACK clip to Negative (–) ground on the vehicle such as the engine block as shown in Figure 17-7.



MAGNETIC PICK-UP COIL TEST Hook-Up - Ford Systems

FIGURE 17-7

CAUTION
When making electrical test connections to the vehicle, do not use the carburetor or other fuel system components as a ground connection, as a spark could ignite the gasoline vapors and cause a fire or explosion.

CAUTION
Do not allow PICK-UP COIL TEST LEAD clips to touch each other or the vehicle ground.

C. **PICK-UP COIL TEST LEAD (12) Connections.**

1. **Scope.** Plug the yellow PICK-UP COIL TEST LEAD (12) connector into the yellow socket on the back of the scope.
2. **Vehicle.**
   a. Disconnect the three wire connector between the distributor and the electronic module.
   b. Connect the PICK-UP COIL TEST LEAD clips to the distributor side of the connector as shown in Figure 17-7.

D. **Select Function.** Rotate FUNCTION SELECTOR (3) to DISTRIBUTOR PATTERN position.

E. **Pattern Controls.**

1. Turn PATTERN POSITION CONTROL (5) clockwise to stop.
2. Turn PATTERN LENGTH CONTROL (6) counter-clockwise to stop.

F. **Turn Scope On.** Press the POWER ON SWITCH (1) to turn scope ON. The switch will illuminate. After the Scope has warmed up for approximately 30 seconds, a horizontal trace will appear on the screen.

> **NOTE**
> A momentary disconnection to the battery will turn scope OFF. Reconnect scope cables to the battery as explained above and press POWER ON SWITCH.

17-11. TEST PROCEDURE.

A. **Select Function.** Ensure the FUNCTION SELECTOR (3) is set to the DISTRIBUTOR PATTERN position.

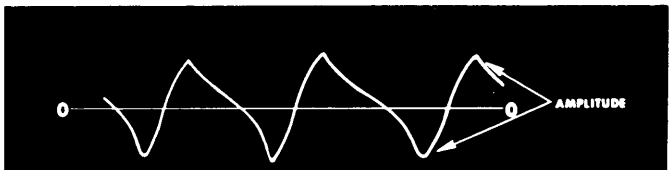
B. **Crank Engine.** Have a helper crank the engine.

C. **Check Pattern.** Compare the pattern displayed on the scope with the patterns illustrated below in Test Results, Figures 17-8 and 17-9. The pattern displayed on the scope screen should match the normal pattern illustrated in Figure 17-8. While the engine is cranking, gently wiggle or flex the pick-up coil wires their full length while observing the scope display. The pattern shown in Figure 17-8 should remain constant. If there is any sign of erratic operation check the pick-up coil wires for insulation nicks, cuts, or wear, and check the terminals for good connections.

D. **Reconnect.** Remove test leads; reconnect all wires and connectors.

17-12. TEST RESULTS.

A. **Normal Pattern.**

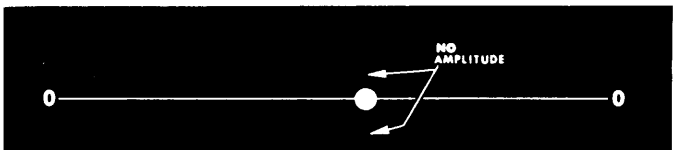


MAGNETIC PICK-UP COIL TEST
Normal Pattern - Ford Systems
FIGURE 17-8.

B. **Unsatisfactory Pattern.** A line with no vertical amplitude is an unsatisfactory pattern. If an unsatisfactory pattern exists, the magnetic pick-up coil is not functioning properly.
Check the pick-up coil with an ohmmeter using the following table as a guide:

Table 17-1. Magnetic Pick-Up Coil Resistance Values

Purple to Orange	Purple or Orange to Ground
SSI 1974-1976 400-800 ~	greater than 70,000 ~
DS-I, DSII 400-1000 ~	greater than 70,000 ~
DS-II, ESCORT/LYNX 650-1300 ~	greater than 70,000 ~

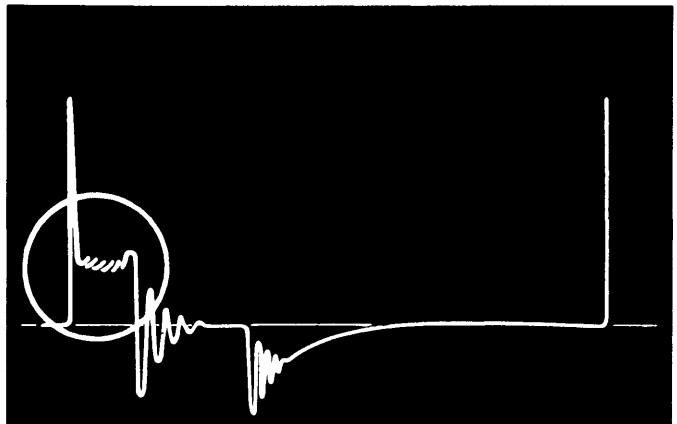


MAGNETIC PICK-UP COIL TEST
Unsatisfactory Pattern - Ford Systems
FIGURE 17-9

CHAPTER 18.
ADDITIONAL SCOPE PATTERNS

18-1. GENERAL. Most ignition problems detected with an oscilloscope are represented by easily recognizable display patterns. However, some unusual patterns are displayed occasionally. The following paragraphs illustrate and explain the most common of these non-standard patterns.

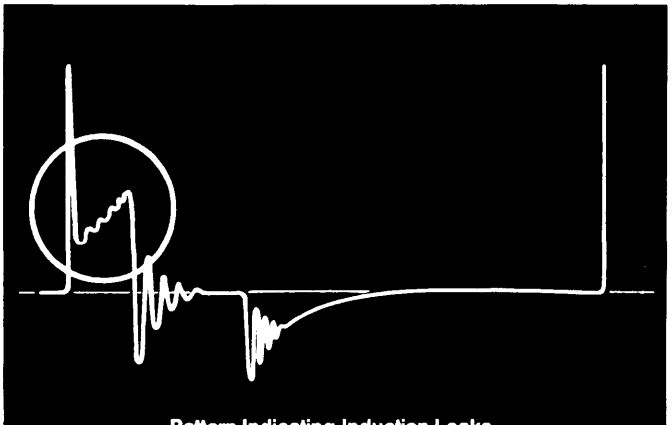
18-2. TURBULENCE. A broken spark line section in the pattern, as illustrated in Figure 18-1, indicates high compression and turbulence. This pattern may be normal if displayed when testing a high-compression engine; but on older cars, it indicates excessive carbon deposits or valve malfunction.



Pattern Indicating Turbulence

FIGURE 18-1.

18-3. INDUCTION LEAKS. If the pattern illustrated in figure 18-2 is displayed for one or more, but not all, cylinders, a manifold leak is indicated. Air may be entering the combustion chamber and causing an abnormally lean fuel mixture condition.

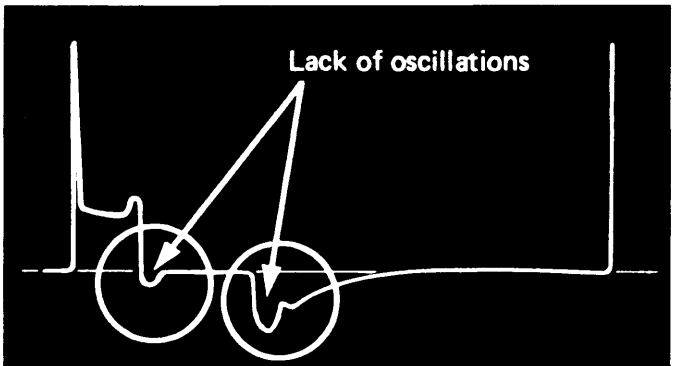


Pattern Indicating Induction Leaks

FIGURE 18-2.

18-4. DEFECTIVE COIL. A pattern that lacks oscillation throughout, as illustrated in Figure 18-3, indicates a defective coil. For additional information, refer to Chapter 11.

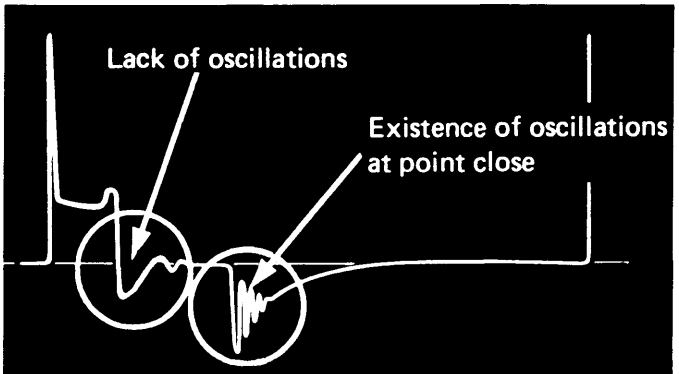
NOTE: This pattern may also occur when the scope is used in conjunction with an automobile analyzer that is set at the DWELL or POINTS RESISTANCE position. Disconnect the analyzer to determine if it is the cause of the problem before testing the coil.



Pattern Indicating Defective Coil

FIGURE 18-3.

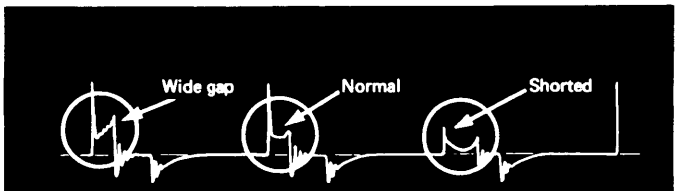
18-5. DEFECTIVE CONDENSER. A pattern that lacks oscillation at the beginning, but has normal oscillation following the point close signal, as illustrated in Figure 18-4, indicates a defective condenser. Refer to Chapter 11.



Pattern Indicating Defective Condenser

FIGURE 18-4.

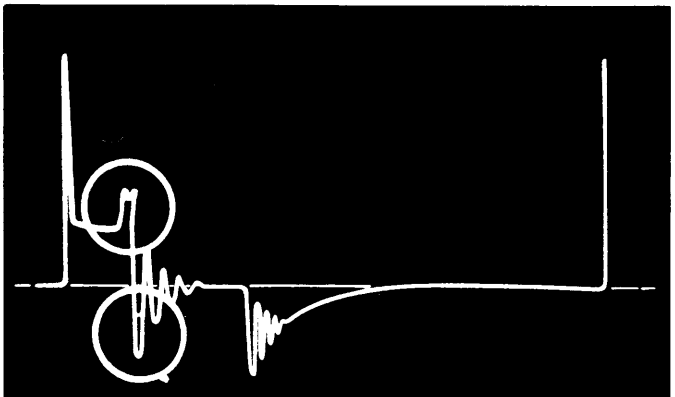
18-6. FAULTY SPARK PLUGS. Shorted spark plugs and wide plug gaps can be detected by close examination of the spark line displayed in the pattern; refer to Figure 18-5. A short, high spark line indicates a wide plug gap. A long, low spark line indicates a shorted plug.



Pattern Indicating Faulty Spark Plugs

FIGURE 18-5.

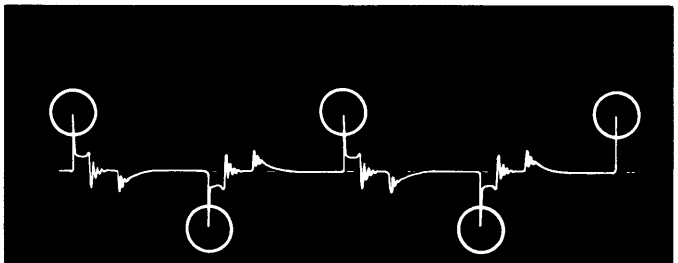
18-7. AUXILIARY GAP SPARK PLUGS. Auxiliary gap spark plugs produce a jagged spike at the end of the spark line and cause the tail of the first oscillation to appear alternately short and long. Refer to Figure 18-6.



Auxiliary Gap Spark Plugs Pattern

FIGURE 18-6.

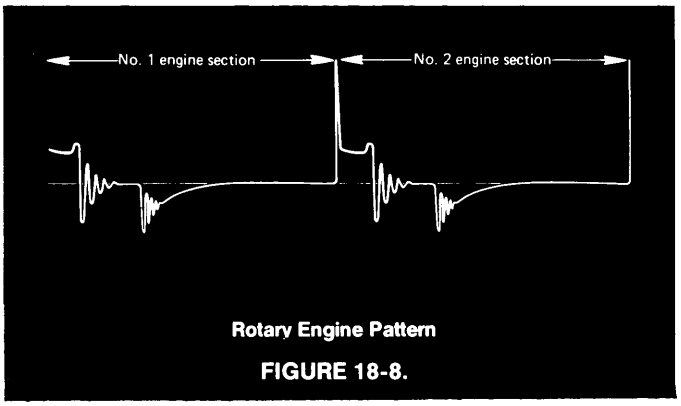
18-8. MAGNETO SYSTEM. A magneto system pattern alternates polarity with each spark plug firing, as illustrated in Figure 18-7. Do not use the 25 KV SPARK Voltage position on the scope when testing a magneto system, as it responds to one polarity only. Use either the DISTRIBUTOR pattern or 50 KV positions to view these waveforms.



Magneto System Pattern

FIGURE 18-7.

18-9. ROTARY ENGINE. A Mazda, two-section rotary engine produces two spark patterns, one for each engine section. These patterns represent the action of either the leading or the trailing ignition, depending on which ignition system (leading or trailing) is being tested. The normal pattern for one engine section is the same as the normal pattern for one cylinder of a piston engine.



Rotary Engine Pattern

FIGURE 18-8.

APPENDIX A

TUNE-UP TIPS

ENGINE STARTS HARD or WILL NOT START

1. Carburetor Trouble Due to:
   - Faulty choke operation.
   - Engine flooded with gasoline.
   - Restriction in carburetor passages.
   - Defective fuel pump.
   - Insufficient supply of gasoline to carburetor due to:
     - Clogged fuel filter.
     - Clogged or restricted gas line.
     - Leaking carburetor gaskets.
     - Damaged or restricted carburetor float.
   - Air leaks at carburetor or intake manifold due to:
     - Loose manifold or carburetor nuts or screws.
     - Leaking carburetor or manifold gaskets.
     - Vacuum line leaks at intake manifold connections or cracked vacuum hoses.
     - Leaks in vacuum operated accessories.
     - Warped mounting surfaces on carburetor or manifold.
     - Cracked intake manifold.
   - Frozen fuel line in cold weather.
   - Fuel tank filler cap vent clogged or restricted.

2. Electrical Difficulties.
   - Battery.
     - Low charge or discharged.
     - Loose or corroded terminals.
     - Poor ground connection.
     - Frayed or corroded cables.
     - Battery of insufficient capacity.
     - Defective alternator or regulator.
   - Ignition.
     - Primary Circuit.
       - Frayed or broken wire lead from coil to distributor.
       - Corroded, dirty or loose connections.
       - Defective condenser.
       - Defective distributor points.
       - Open ballast resistor.
       - Defective coil.
     - Secondary Circuit.
       - Corroded ignition cable terminals.
       - Coil tower cable not properly seated in distributor.
       - Open coil tower cable.
       - Cracked insulation on ignition cables.
       - Weak or defective coil.
       - Excessive moisture on ignition system components.
       - Cracked distributor cap.
       - Damaged or defective spark plugs.
       - Damaged or defective rotor.
   - Ignition Switch.
     - Loose contacts.
     - Corroded or defective contacts.
     - Ballast bypass circuit defective.
   - Starter Motor.
     - Defective starter solenoid.
     - Open or shorted windings.
     - Starter pinion damaged or stuck in fly wheel gear.
     - Slipping clutch in drive pinion.
     - Faulty neutral safety switch on cars with automatic transmission.

3. Poor Engine Compression resulting from:
   - Loose cylinder head bolts.
   - Loose spark plugs.
   - Damaged or leaking cylinder head gasket.
   - Damaged or burned valve seats.
   - Weak or broken valve springs.
   - Improper valve clearance or warped or gummed valve stems.
   - Worn, broken, weak or stuck piston rings.
   - Scored cylinder walls.
   - Cracked cylinder block.
   - Excessive internal engine friction.

SPARK PLUG PROBLEMS

Cracked exterior porcelain.
Improperly spaced gap.
Fouled plugs.
Incorrect ignition coil polarity.

ENGINE MISFIRES WHEN IDLING NORMAL ENGINE TEMPERATURE

Air leaks in intake manifold or carburetor resulting from:
- Loose manifold connections or leaks occurring in vacuum lines and vacuum operated accessories.
- Loose manifold bolts.
- Broken or damaged intake manifold or carburetor gaskets.

Crack in manifold.
Warped or damaged manifold contacting surface.

Incorrect ignition timing.
Spark plug malfunction.
Ignition wires open or leaking to ground.
Defective PCV system.
Defective ignition condenser.
Spark advanced too far.
Defective ignition switch.
Defective valves.

LACK OF POWER or HIGH SPEED PERFORMANCE

Insufficient or unequal engine cylinder compression.
Improper ignition timing.
Inoperative manifold heater valve (valve held in closed position).
Improper carburetion.
Restricted carburetor air inlet resulting from:
Dirty air cleaner.
Choke valve not completely opening.
Throttle linkage not properly adjusted and carburetor throttle valve not completely opening.
Carburetor accelerating pump not functioning properly.
Improper fuel pump operation.
Partially restricted or clogged exhaust pipe. muffler, or tail pipe.
Excessive engine temperatures.
Preignition.
Excessive engine friction resulting from:
Inadequate internal clearances (bearings and pistons).
Use of extreme pressure piston rings.
Clutch slippage.
Excessive rolling resistance resulting from:
Dragging brakes.
Tight wheel, pinion, differential, or transmission bearings.
Misalignment in power transmitting units.
Misalignment of rear axle.
Underinflated tires.
Incorrect valve timing.
Worn lobes on camshaft.
Defective spark plugs.
Defective ignition points.
Faulty ignition coil.

SPARK KNOCK (DETONATION)

Spark knock (detonation) causes a metallic ringing sound, often described as a "ping", and is usually encountered when the engine is laboring, accelerating rapidly, or overheating.
Carbon deposits in combustion chamber.
Ignition timed too early.
Faulty distributor advance governor (weak springs).
Spark plugs.
Incorrect type of plug (using a plug which is too hot).
Porcelains or electrodes carbonized or burned.
Lean fuel mixtures.
Excessive engine temperatures.
Poor grade of fuel.
Inoperative manifold heater valve (valve held in closed position).
Inoperative EGR valve.

ENGINE BACKFIRING THROUGH CARBURETOR

Improper ignition timing.
Improperly seating valves, especially intake.
Incorrect valve timing.
Worn lobes on camshaft.
Excessively lean carburetor mixture.
Intake manifold air leaks.
Defective cylinder head gasket (especially between cylinders).
Poor quality of fuel.
Secondary wires improperly installed (crossed) in distributor cap.
Distributor centrifugal weights sticking.
Engine cold and choke too lean.
No accelerator pump action.

ENGINE CONTINUES TO RUN AFTER IGNITION IS TURNED OFF (DIESELING)

Idle speed set too high.
Improper engine timing.
Too high a heat range on spark plugs.
Defective idle stop solenoid.
Inoperative emission controls.
Excessive engine temperature.

APPENDIX B

REPLACEMENT PARTS

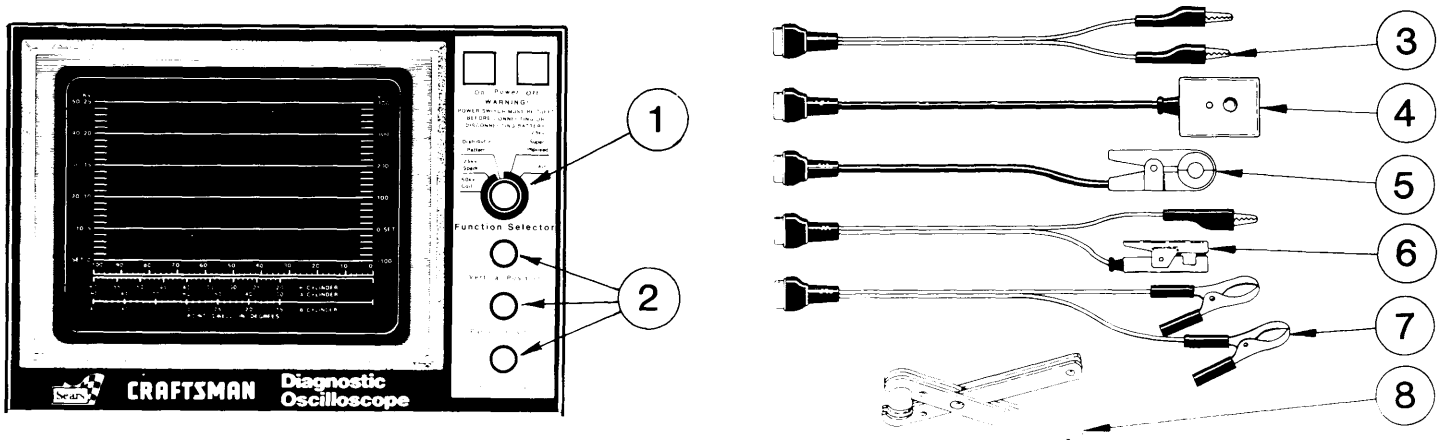


FIGURE 19-1.
REPLACEMENT PARTS

DIAGNOSTIC OSCILLOSCOPE

MODEL 161.21056

Key No.	Part No.	Description
1	450-143	Function Selector Knob w/skirt
2	450-142	Control Knob
3	38-827	Cable, Magnetic Pick-up Coil Test
4	38-830	Capacitive Pick-up - HEI
5	38-829	Capacitive Pick-up - External Coil
6	38-828	Inductive Clamp, Alternator Cable
7	38-826	Cable, Power
8	450-141	Plier, Insulated Fiber
9	2-176202	Manual, Owners (Not illustrated)
10	1000-1153	Cable Kit (contains key no's. 3-8 inclusive)

TABLE 19-1 REPLACEMENT PARTS LIST

All parts listed may be ordered from any Sears. Roebuck and Company store or service center.

WHEN ORDERING REPAIR PARTS, ALWAYS GIVE THE FOLLOWING INFORMATION:

1. PART NUMBER
2. MODEL NUMBER 161.21056
3. PART DESCRIPTION
4. NAME OF ITEM— DIAGNOSTIC OSCILLOSCOPE

If the parts you need are not stocked locally, your order will be electronically transmitted to a Sears Repair Parts Distribution Center for expedited handling.

SEARS

owners manual

MODEL NO.

161.21056

HOW TO ORDER REPAIR PARTS

SEARS / CRAFTSMAN®

DIAGNOSTIC OSCILLOSCOPE

Now that you have purchased your Diagnostic Oscilloscope with Inductive Pickup, should a need ever exist for repair parts or service, simply contact any Sears Service Center and most Sears, Roebuck and Co. stores. Be sure to provide all pertinent facts when you call or visit.

The model number of your Diagnostic Oscilloscope with Inductive Pickup can be found on the nameplate.

WHEN ORDERING REPAIR PARTS, ALWAYS GIVE THE FOLLOWING INFORMATION:

PART NUMBER PART DESCRIPTION

MODEL NUMBER NAME OF ITEM

All parts listed may be ordered from any Sears Service Center and most Sears stores.

If the parts you need are not stocked locally, your order will be electronically transmitted to a Sears Repair Parts Distribution Center for handling.

SEARS, ROEBUCK AND CO. U.S.A.
CHICAGO, ILLINOIS 60684